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STUDIES FROM THE PSYCHOLOGICAL LABORATORY  
OF HARVARD UNIVERSITY

On the Psychophysiology of a  
Prolonged Fast

By

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## EXPERIMENTAL CONDITIONS

In the spring of 1912 Agostino Levanzin, a lawyer by profession came from Malta to undergo a prolonged fast at the Nutrition Laboratory of the Carnegie Institution of Washington in Boston. It was deemed advisable, in order to have as complete an investigation as possible of all the conditions during fasting to supplement the physiological by mental tests. It is the purpose of this paper to present the results of the latter.

Levanzin has for a number of years been interested in the subject of fasting, believing that most human ills can be cured by abstinence from food for a long period of time. He had already made one fast of forty days. It was his claim that during that period all his mental faculties so increased in efficiency, that he could hear, see, smell and think better and that on the 26th day he was able to plead a case in the law court. His ostensible purpose in coming to America was to substantiate, if possible by strict scientific methods his own casual observations. It is desired to emphasize this attitude in order to convey an idea of the keen interest which he showed during the tests and the willingness with which he attempted to fulfil all conditions, a co-operation the thoroughness of which might have been doubted in the case of a man fasting merely for pay.

Before his first fast he weighed about one hundred and eighty pounds and after the fast 140 pounds. When he arrived at the laboratory his weight was 134 lbs., at the end of the fast 106 lbs.<sup>1</sup> He was a man of 40 years of age, of medium height and slender. When not in conversation his manner was languid and it is perhaps due partly to this that he seemed to lack physical strength and vigor. In temperament he is of the decidedly emotional southern type, sensitive, quick to anger, loquacious, credulous and fertile in imagination. This last characteristic is probably responsible for the fact that the unusual appeals to him. Once having espoused a cause or entertained an idea he holds to it

<sup>1</sup> There was an almost steady decrease of about one pound a day.

tenaciously. He is a man of a few fixed ideas or complexes which form the basis of his mental life.

L. arrived at the laboratory on the afternoon of April 10th. He took his last meal on the evening of April 13th and his fast was considered to date from the morning of the 14th. Absolutely nothing but 750 cc of distilled water daily passed his lips during the thirty-one days. He lived on a balcony in the laboratory, slept at night in the calorimeter and was watched constantly. His luggage was examined on his arrival and all of his mail was opened at his request in order to preclude every possibility of his receiving a stimulant through those sources. His daily program consisted of tests by different specialists and varied but slightly. His leisure he spent in reading and writing and receiving guests. Unfortunately the weather for a good part of the time was unfavorable, but when possible he went on the roof for an hour or took a ride in an open carriage with an attendant.

The tests herein described lasted from April 11 to May 15th inclusive.<sup>2</sup> Food was taken on April 10th, 11th, 12th, and 13th and again on May 15th. The intervening 31 days were fast days. The psychological tests were made at five p. m. each day and lasted one hour. During the half hour before the tests he rested.<sup>3</sup>

From the above it is seen that the psychological tests were made under as nearly as possible ideal conditions. Alone from the fact of the complete control of diet and occupation the tests seemed worth the attempt, for it is seldom that psychological experiments can be conducted over such a length of time under such constant conditions. Perfect as they were, however, one factor important to mental measurement was found to vary, that is the mood of the subject. As far as L's willingness to cooperate is concerned there was nothing to indicate to the experimenter a change in this attitude or that his general interest in

<sup>2</sup> An idea of his intelligence and interests may be obtained from the association reactions. See appendix II.

<sup>3</sup> The tests on April 11th were tentative and are not included in the curves.

the work relaxed at any period of the series. On the other hand there is no doubt that he was happier during the first days, rather depressed and silent in the middle and somewhat irritable and excitable toward the end, although this irritation was at no time directed toward the tests. The greatest depression occurred after a prolonged continuation of bad weather and very much decreased after he was able to go out in the air. He was also much happier after having received visitors. He himself remarked that the monotony of the program was the most difficult thing he had to endure. As to his physical condition he made few complaints. He felt well throughout and insisted that he had no sense of hunger, not even during the first days.<sup>4</sup> The only discomfort of which he spoke was the coated condition of his tongue and the unpleasant taste in his mouth. It was his idea that the fast should continue until this disappeared and it was for this reason that he was loath to break his fast on the 31st day.<sup>5</sup> Although he seemed more feeble toward the end of the fast and gave one the impression of a man convalescing from a weakening illness, yet he was always able to walk without assistance and at no time was it necessary to omit or alter a test through lack of strength on his part. On May 15th, the day he broke his fast, he suffered severe colic induced by the food he ate and although tests were made, the conditions were most unfavorable. It had been planned to continue the examination for several weeks longer, in as much as such tests would ob-

<sup>4</sup>This is contrary to the experience of most fasters. W. B. Cannon and A. L. Washburn (*An Explanation of Hunger*. *Am. Jour. of Physiol.*, 1911-12, p. 441) describe the feeling of hunger as follows: "Hunger . . . is a dull ache or gnawing sensation referred to the lower mid-chest region and the epigastrium. It is the organism's first strong demand for nutriment, and, not satisfied, is likely to grow into a highly uncomfortable pang, less definitely localized as it becomes more intense. He further states (p. 442): There is abundant evidence, however, . . . that during continued fasting hunger wholly disappears after the first few days." Professor Cannon has recently informed the author that from what certain fasters have told him he believes that sensations of hunger may be absent from the beginning; that in fact some people may never have the sensations of hunger as just described.

<sup>5</sup>Thirty days were considered sufficient for the physiological tests and he was allowed one day more to excell Succi's record.

viously be of inestimable value for comparison with the fasting tests. Unfortunately that was quite impossible under the circumstances and an entire year elapsed before further records could be obtained.

Several factors influenced the selection of the tests. In the first place the time was limited. There was only one hour daily available and it seemed advisable to arrange for as many tests as possible during this hour in order to obtain a good mental picture. It was therefore necessary to choose short tests and also those requiring the minimum of effort, as one test had to follow the other without pause for recuperation. For example prolonged tests for fatigue would have been of great value but they could not be considered. In the second place the fasting began a few days after L's arrival and little time could be devoted to preliminary trials in order to obtain the best combination and the program once arranged could not be fundamentally changed.<sup>6</sup> After consultation with Professor Dodge a series of tests were selected. A few days' experience, however, showed the necessity of several alterations, and the revised program was as follows: 1. Rote memory for words, 2. Tapping test, 3. Strength test, 4. Tactual Space threshold, 5. Touch threshold, 6. Free association and reproduction reactions, 7. Association reactions, genus-species, 8. Association reactions; noun-verb, 9. Cancellation test, 10. Hand-writing,<sup>7</sup> 11. Visual acuity, 12. Memory for words after 55 minutes. Later the touch threshold, which was taken on the under part of the lower forearm with a von Frey hair, was discontinued on account of the impossibility of obtaining reliable results in a short period of time. The association reaction genus-species was also omitted through difficulty in finding sufficient reaction words of equal simplicity. In addition to the tests Levanzin was requested to describe all the dreams he had on the previous night.<sup>8</sup> This was given before the visual acuity test. All the tests with the exception of that of visual

<sup>6</sup> A few minor changes were introduced.

<sup>7</sup> A superficial examination of the daily records revealed no change. A systematic examination of the data has not yet been made.

<sup>8</sup> See appendix I.

acuity were made in a small room free from disturbing influences.<sup>9</sup>

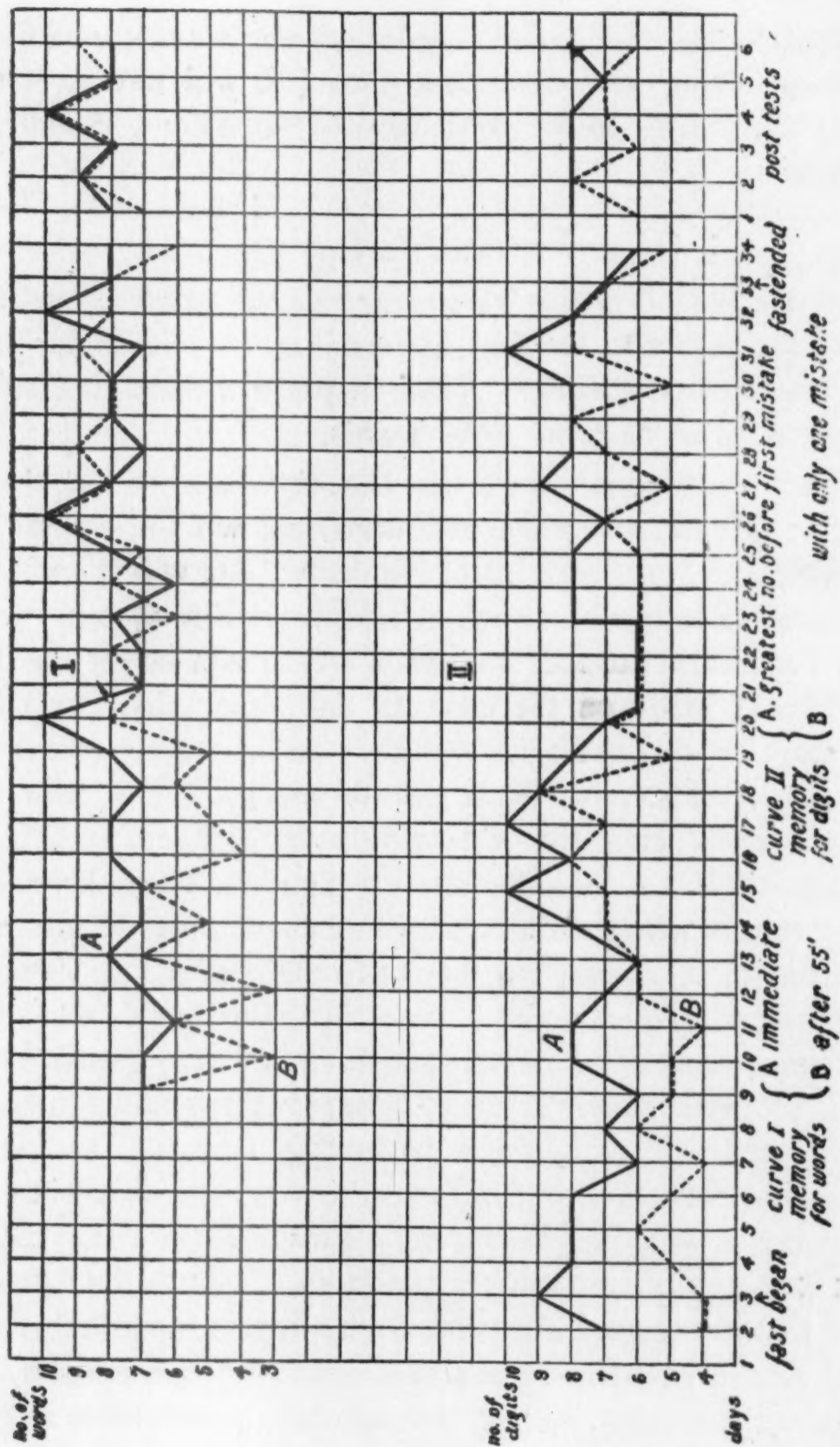
The general conditions of the experiments and the nature of the tests having been described, each test will now be treated separately, first as to the particular conditions and second as to the results.

### *Memory for Words*

Ten one syllable words were chosen and these were read twice to the subject, who recalled as many as possible immediately after the second reading. After fifty-five minutes the subject again attempted to recall these words.

From the curves it will be seen that there are marked fluctuations, a circumstance which is always met with in mental tests and which will be found in all the curves. It will therefore be only possible to speak of general tendencies throughout. In the curve for immediate rote memory (IA) it will be seen that the poor record made on the eleventh day (the third day of the test) only occurs once again and that on the twenty-fourth day, while a perfect score of the ten words was made three times and all of them during the last two-thirds of the fast, so that although the initial records occur frequently toward the end, yet the curve as a whole shows a slight general improvement, but so slight that much significance cannot be attached to it. The curve (IB) indicating the amount of retention after 55 minutes, on the other hand shows a more or less steady improvement until near the end of the series and even when these last trials are included the general tendency of the curve is decidedly upward. In four instances and these all in the last two-thirds of the series the retention curve crosses the rote memory curve, which means that on these days the retention after the lapse of almost an hour was better than the immediate memory. Levanzin, upon being questioned was emphatic in his assurance that he never thought of the words in the interim, so that this relative improvement in retention was not due to any conscious repetition during the pause.

<sup>9</sup> It is much to be regretted that time and conditions prevented tests for the thresholds of audition and smell.



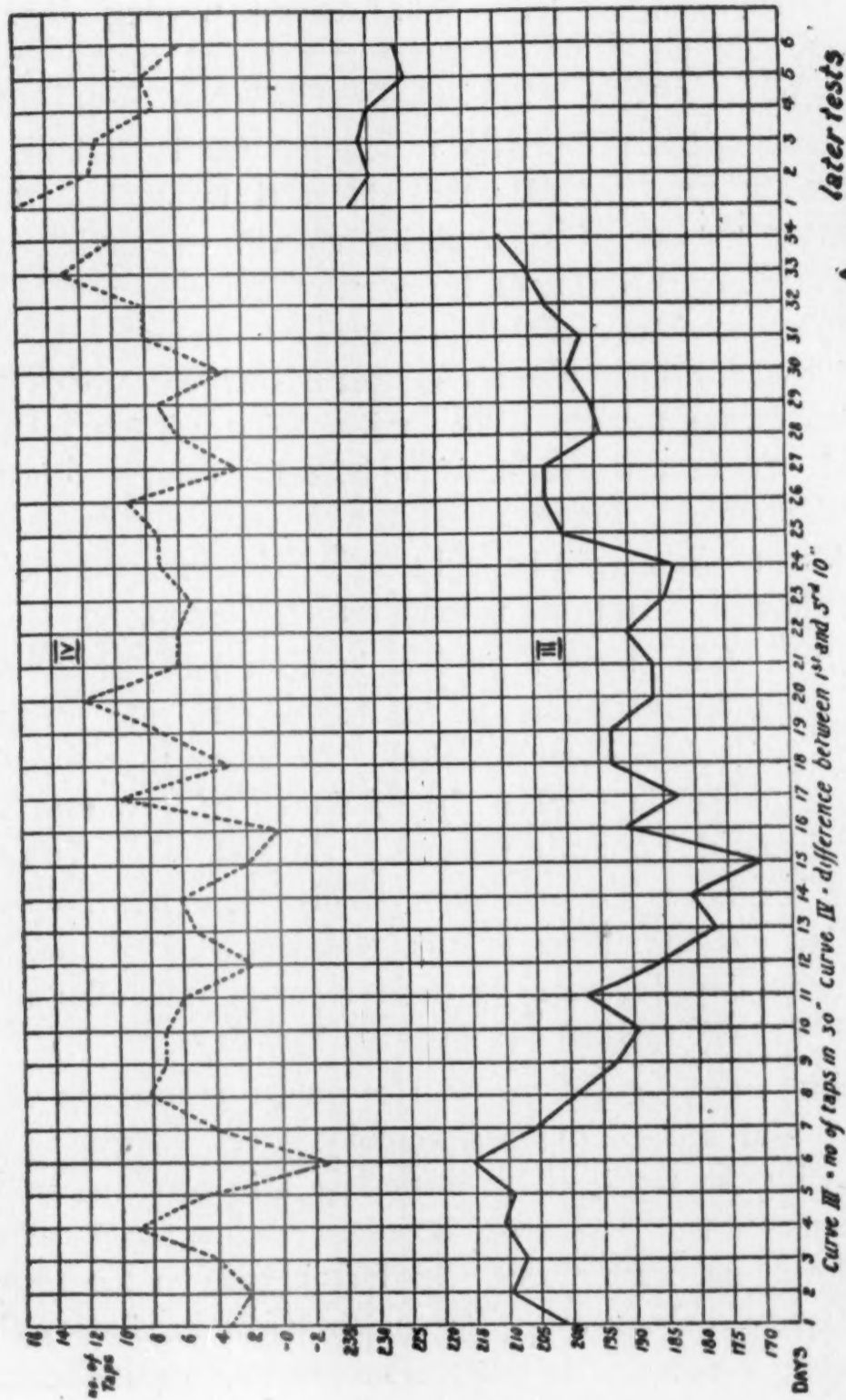
*Tapping Tests*

The instrument used was similar to the tapping-board described by Whipple.<sup>10</sup> It consisted of a board 12 cm. square covered with aluminum. This metal is not very well adapted for the tapping-board, but it was selected for its lightness, it being thought quite probable that the tests would have to be made toward the end of the experiments with the subject lying down and the board resting on his chest. The stylus also had an aluminum point. The records were taken on a kymograph. The tapping lasted for thirty seconds and periods of ten seconds were marked off on the records. The subject being left handed used that hand. As he was over sensitive to cold during the fast he wore, beside a heavy woolen undershirt, a heavy dressing-gown, which added to the weight he had to lift. Neither the hand nor arm was allowed to rest on the table during the tapping.

The curve (III) shows a gradual improvement for the first six days when the maximum of the series—215 taps or about seven taps per second—was reached. The curve then descends for the next nine days when the minimum of 170 taps was reached. From this point to the end of the series there is a rise to a point just below the maximum. This rise is not, however, gradual, but consists rather of two plateaux, one of nine the other of seven days separated by decided jumps and followed by a gradual but very marked end spurt of four days.

The initial improvement can well be due to practice in using those particular sets of muscles, combined with increasing familiarity with the work. This same rise also occurred in the dynamometer tests. The drop, however, begins much sooner than in the dynamometer tests. In fact it ends in the former where it begins in the latter. One can therefore hardly say that it is a matter of muscular fatigue. The first explanation to suggest itself is a lessening in interest, and this is strengthened by the fact that the drop occurs at that time when he was most affected by the monotony of the routine work. In this test less

<sup>10</sup> Whipple's Manual of Mental and Physical Tests. p. 101.



fast ended

fast began

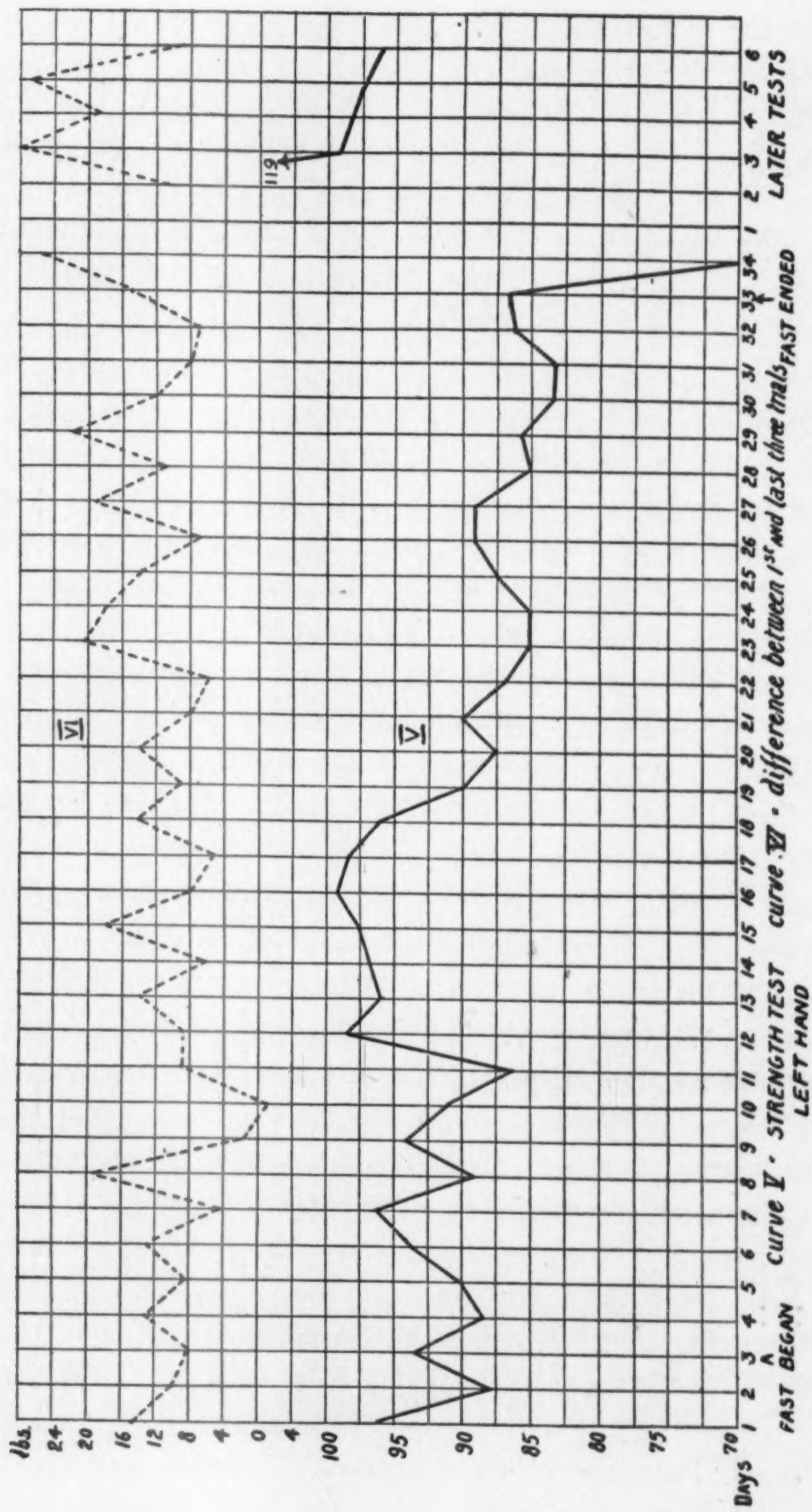
depends for improvement upon the increase in muscular power than in the dynamometer tests, the main factor being the rapidity of action. We know that the rate of the reaction time is greatly affected by changes in attention and it is probable that the betterment in the muscular control, which we may assume from the results of the dynamometer tests did occur, was insufficient to offset this loss of interest. The results of the last days confirm this assumption, for here we undoubtedly have the effect of interest in an end spurt, which, notwithstanding muscular fatigue which was undoubtedly present at this time, brings the curve back to a higher level.<sup>11</sup> In regard to the two plateaux referred to above, it seems plausible to infer from what we know of the causes of plateaux in the learning process in acts of skill that these sudden rises to new levels are due to the learning of some new method or short cut. Here the most obvious short cut is the lessening of the height of the stroke.

An examination of the difference curve (IV), which has been obtained by subtracting the results of the first ten seconds from that of the last ten, still further confirm the assumption of a wavering in interest. There is a gradual increase in the amount of this difference, which indicates fatigue. This increase is particularly marked toward the end when the records are improving, which means that the improvement is caused by a spurt during the first ten seconds.

In general it may be said that although initial lack of interest<sup>12</sup> and later muscular fatigue played a rôle, both factors being directed toward a decrease in the amount of work, yet the will impulse toward the end was sufficiently great to bring the curve back to its initial level and almost to its maximum.

<sup>11</sup> This is an error which is bound to occur with this form of tapping board. The writer has, therefore, recently constructed a board which regulates the height of the stroke, thus making it a constant factor.

<sup>12</sup> Against this suggestion is the fact that other tests did not show this lack of interest, but it is quite possible that the interest varied with the different tests.



*Strength Tests*

These tests immediately followed the tapping tests. The subject stood and received the dynamometer, one of the Collin type, from the experimenter, and pressing it returned it to the experimenter. The record was noted and the instrument returned. The interval between trials was about one second. Ten trials were made with the left hand followed by ten trials with the right.

Both in the right (VII) and left hand (V) curves there is an initial falling off, which is more marked with the former hand. The latter, however, continues to fall to the 11th day on which day it takes a decided drop, while the former declines more gradually to the ninth day, when it reaches its maximum. Both curves then rise to a maximum, which is reached by the left hand on the 16th day and by the right hand on the 12th day (the record of the first day not being considered in speaking of this maximum). The curves then fall, the left much more than the right, especially in the middle of the series, the former reaching its minimum on the 31st day. Both curves show a slight end spurt. This is, as a glance at the curve will show, merely a rough picture, there being decided rises and falls throughout.

In interpreting the curve it must be remembered that the left hand is the practiced hand and it can therefore be assumed that the muscles of that hand are the stronger. In fact the results make this more than an assumption, for the record of this hand is at all times decidedly better than that of the right hand. The initial falling off is what one must expect when the subject is not accustomed to the particular muscular exercise. There is a great exertion at first and the muscles, skin and subcutaneous tissue feel the usual strain for several days. Those muscles least accustomed to exercise are the most effected. It is for this reason that the right hand record drops more than that of the left hand. Then the muscles gradually recover and the effect of practice begins to appear. Acting against the practice is

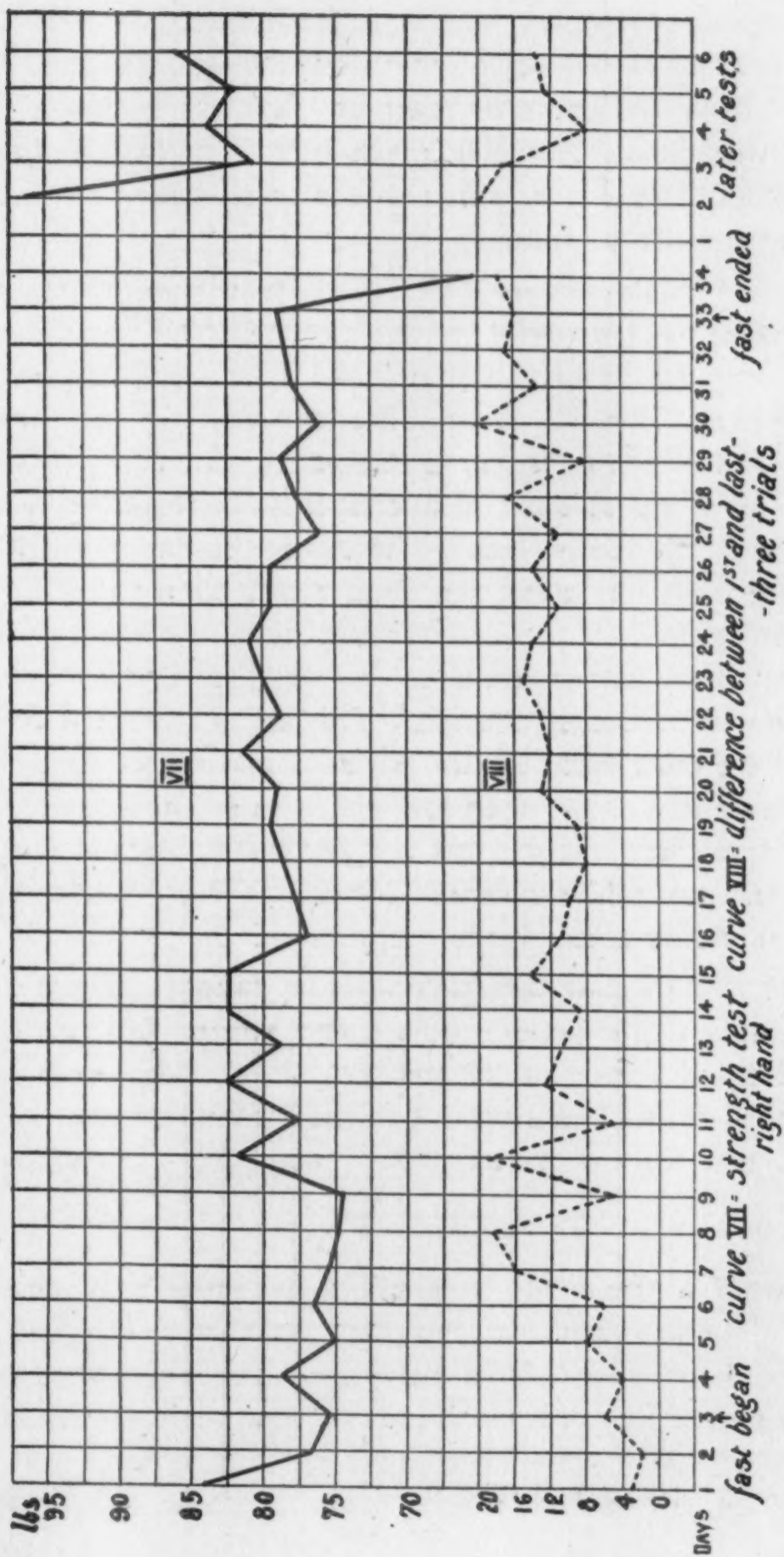
the increasing fatigue. The right hand being the unused hand gives practice more chance for its influence and although fatigue never allows the curve to reach its first day's record, yet the drop which soon begins is much more gradual, as has been pointed out, than it is with the left hand, where the effect of fatigue is more prominent.

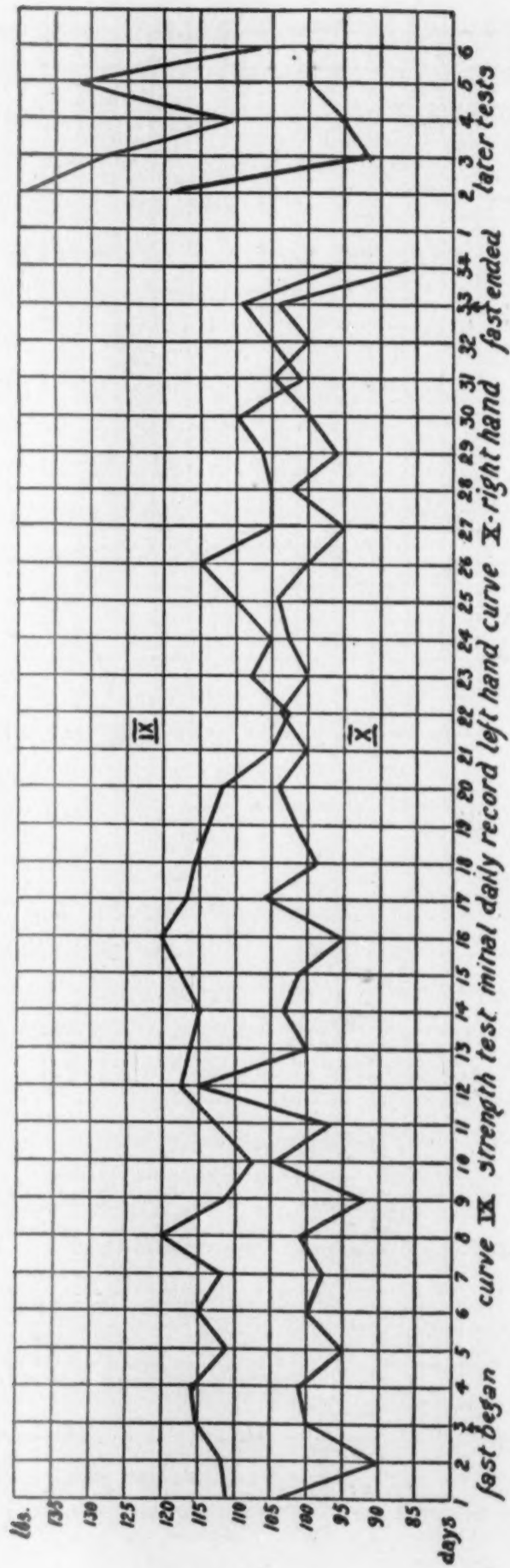
The difference curves (VI, VII), which were obtained by subtracting the average of the last three records of each day from the average of the first three helps to strengthen the conclusions just drawn. The rise of the difference curve at the same time as the fall of the main curve, means, of course, increasing fatigue, which shows itself in a greater and greater drop toward the end of the daily series. This rise in the two difference curves is relatively about the same, which means that the daily increase in fatigue is relatively the same for the two hands. Further, if we glance at curves (IX, X), we find additional indications in the same direction. This curve is plotted from the first of the daily series of ten trials. This trial is least effected by fatigue and shows therefore the greatest influence of practice. Here there is a gradual rise for the right hand until next to the last day, while the curve for the left hand begins to drop where it should according to our analysis.

In general we may therefore say that fatigue appears in both hands early in the series. The curve for the left hand drops far below the record of the first few days. The curve for the right hand shows less drop due to the greater influence of practice, so that the two curves tend to approach one another.

#### *Tactual Space Threshold*

A pair of dividers with wooden tips were used as an aesthesiometer. The threshold was found on the volar side of the forearm, about four inches from the elbow. The points were applied on either side of a red ink dot which was made on the arm on the first day and renewed when necessary. The method of minimal change with ascending and descending series, was employed.





Five trials excluding one-point "vexier" trials were made at each distance. Four correct out of five was considered the threshold.<sup>13</sup>

For the first few days the curve (XI) keeps the high level of 7 cm. On the seventh day there is a drop to 5.5 cm., then a slight rise to a level of 6 cm. and a high threshold of 6.5 cm. on the 14th day followed by a fall to the minimum of 5 cm. on the 22nd day, which minimum is again reached on the 26th and 30th days. The final days show a rise to 6 cm. The decided drop on the seventh day may be due to adaptation to the experiment, which in this instance means the adoption of a definite and clear criterion of discrimination. The drop in the middle of the series after a more or less constant level may be due to a similar cause, that is a change to a better criterion. The rises in the latter part of the curve are never as great as those of the first part, although on the last day the curve again reaches 6.2 cm. This threshold had to be placed at 5 correct judgments as there was a jump from 3 correct judgments. This makes the threshold probably too high. If we omit the first day and compare the average of the period from the 7th to the 20th day with the average of that from the 21st to the 34th day we find a difference of .4 cm. in favor of the latter period. We may say then in general that there is an improvement, although very slight in the discriminating process, but that there is no end spurt, which latter from the very nature of the process under investigation is not to be expected.

#### *Rote Memory for Digits*

The usual rote memory test was employed. Increasing series of digits beginning with four digits were read aloud once by the

<sup>13</sup> It had been intended to call three out of five the correct threshold, but this was not found feasible. The threshold is probably too high, but for the present purpose, where the change and not the absolute threshold is being investigated this does not matter.

The curve shows no record for the 4th, and 5th days. The experimenter was absent on these days and the physican, who kindly volunteered his services, did not deem himself sufficiently skilled in this particular test to undertake it.

experimenter to the beat of a metronome with one second intervals and were repeated as far as possible by the subject. The combinations of digits varied daily.

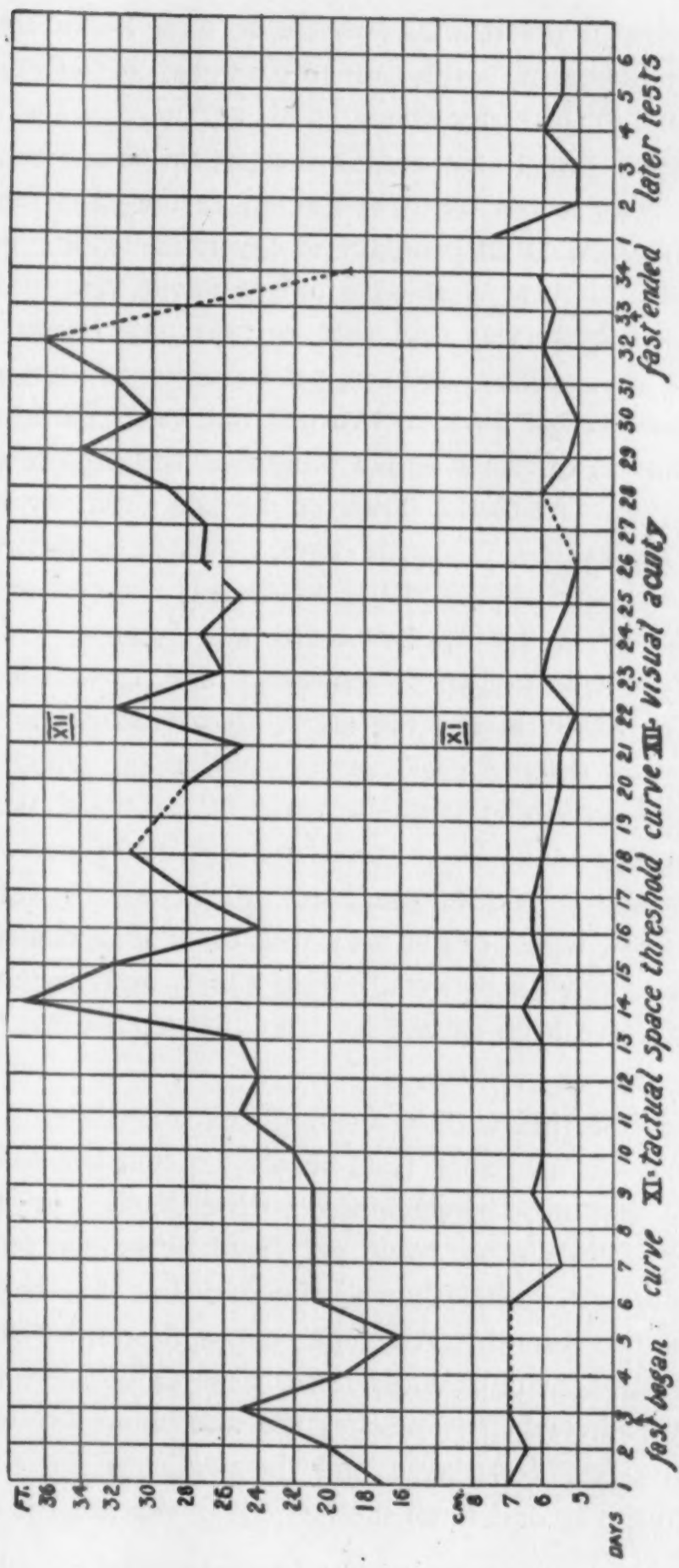
Curve II A is obtained by taking the last series that contains only one mistake, curve II B by taking the number which immediately precedes the one containing the first mistake. Curve A, which gives a picture of the rote memory process shows two apexes of maximal value near the middle and another on the 31st day. There is, however, a very low minimum in the second half of the curve and a decided drop from the maximum of the 31st day. One can, therefore, hardly speak of an improvement! The most that can be said is that the subject was, toward the end of the fast, again able to reach the maximum record of 10 digits obtained near the middle of the series. We see from the curve B that on the 3rd day a mistake was made at four digits, yet the retention is 9 digits; on the 11th day a mistake at four digits and a retention of eight, etc. It seems fair to assume from these results that curve B represents in a rough manner the degree of attention. It is only inattention that can produce results like the above. Curve B shows a decided rise to the eighteenth day, when it reaches a maximum and although it follows a lower level from this day it never reaches the minimum of the first third of the series. One may therefore say that there is an improvement in the state of attention, at least for this experiment, as the fast progressed.

#### *Association Tests*

The free association experiments consisted of the daily presentation of a list of twenty words which were selected principally from the lists prepared by Woodworth and Wells<sup>14</sup> and with the exception of the list of May 9th, which was a repetition of that of April 11th they were all different.<sup>15</sup> Several days after the tests were begun it was thought advisable, in order to

<sup>14</sup> Association Tests, Psych. Monog. vol III, 5, 1911.

<sup>15</sup> The lists will be found in appendix II. In a few instances the same word appears in two lists.

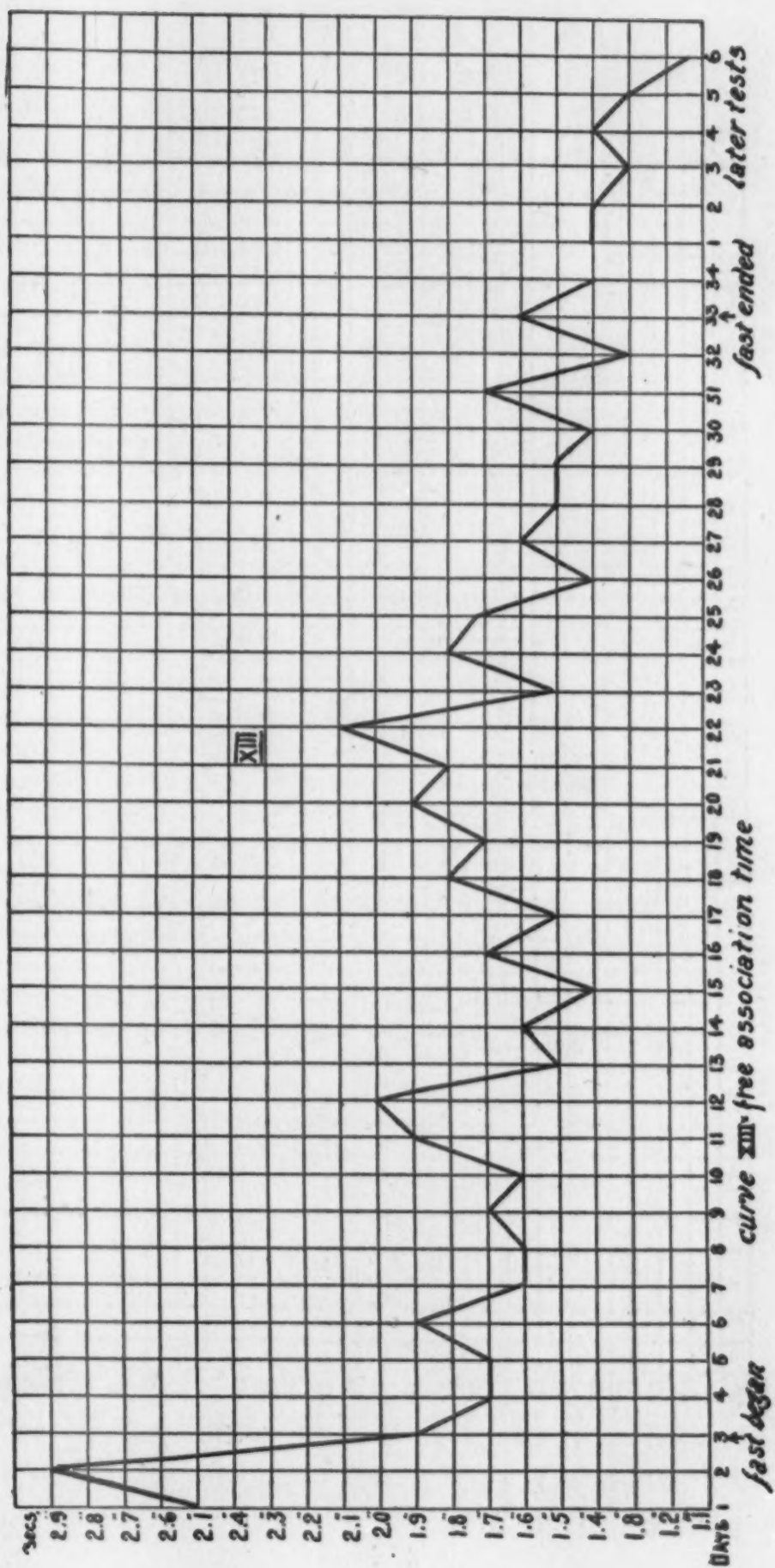


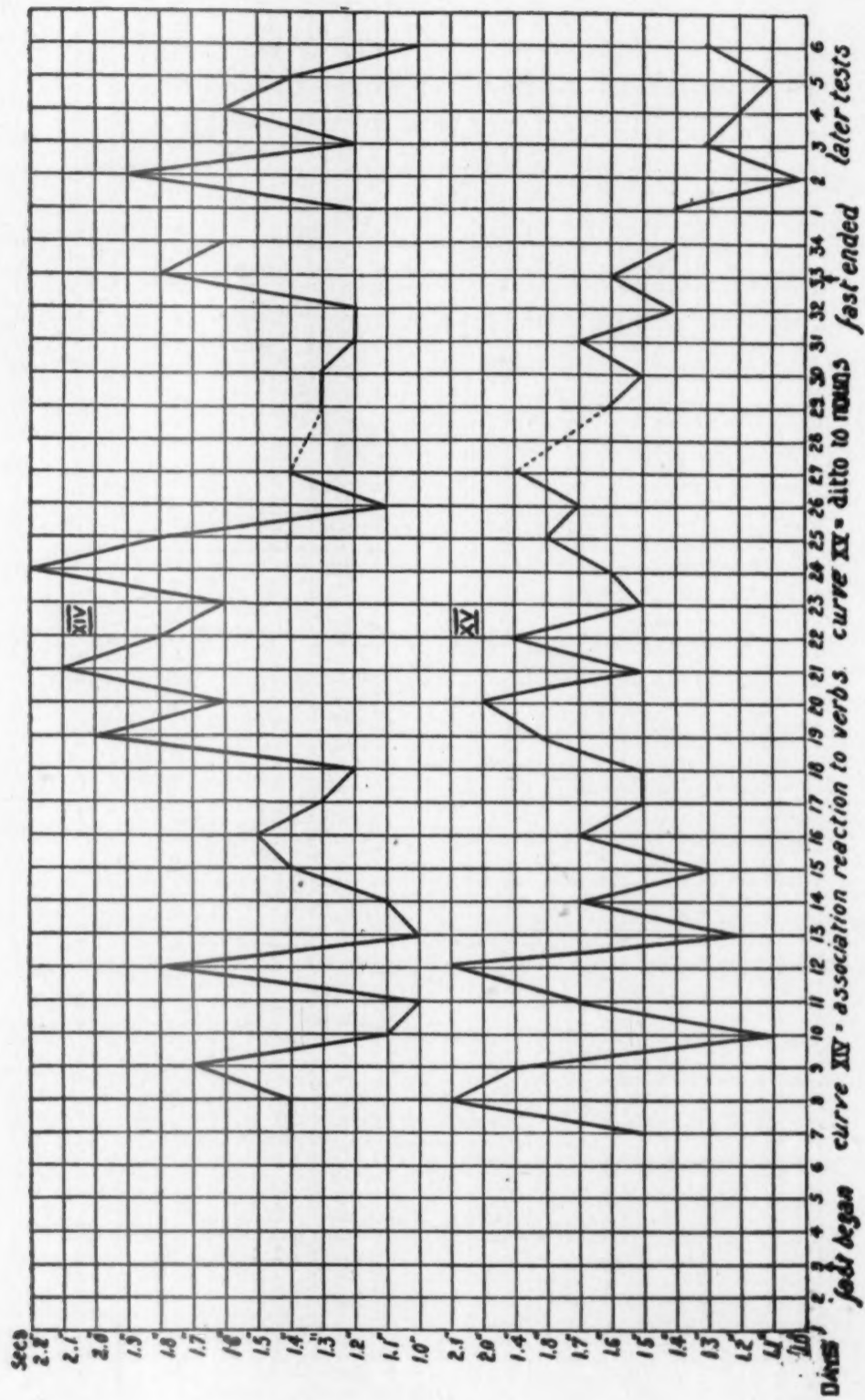
make the lists as uniform as possible, to have them composed of an equal number of verbs, concrete nouns, adjectives and abstract nouns, in the order given. This arrangement was adhered to from April 18th to the end of the tests with the exception of May 9th. The words were read aloud by the experimenter and the time taken with an ordinary stop-watch. The reproduction experiments followed these with only a pause of a minute. Although the subject was told that he need not repeat the same word, if it did not come at once, yet there is little doubt that his efforts were always directed toward that end. Levanzin had a good command of the English language although it is not his native tongue. At times, however, he had difficulty in finding the word he wanted. In such cases, he made a gesture as soon as the idea came to him and the watch was snapped at that time rather than when the English word was found. This method of procedure was not often necessary and it seemed a legitimate means of balancing the slight disadvantage he had as a foreigner. A reserve list was prepared upon which to draw when he did not understand the word of the main list.

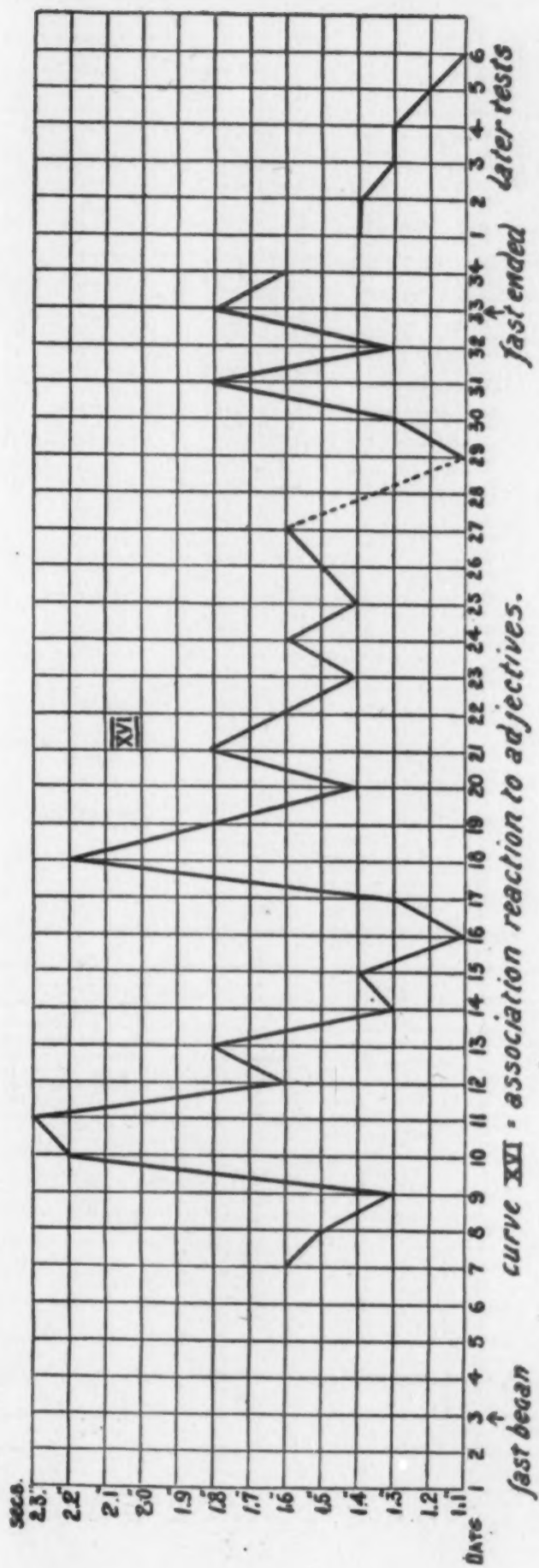
The curve (XIII) is plotted from the daily average. The average was used in order the better to include the influence of the long times, which might very well be of importance in these tests.<sup>16</sup> The few exceptionally long times, such as 20 seconds, which may have been caused by emotional complexes, were not included.

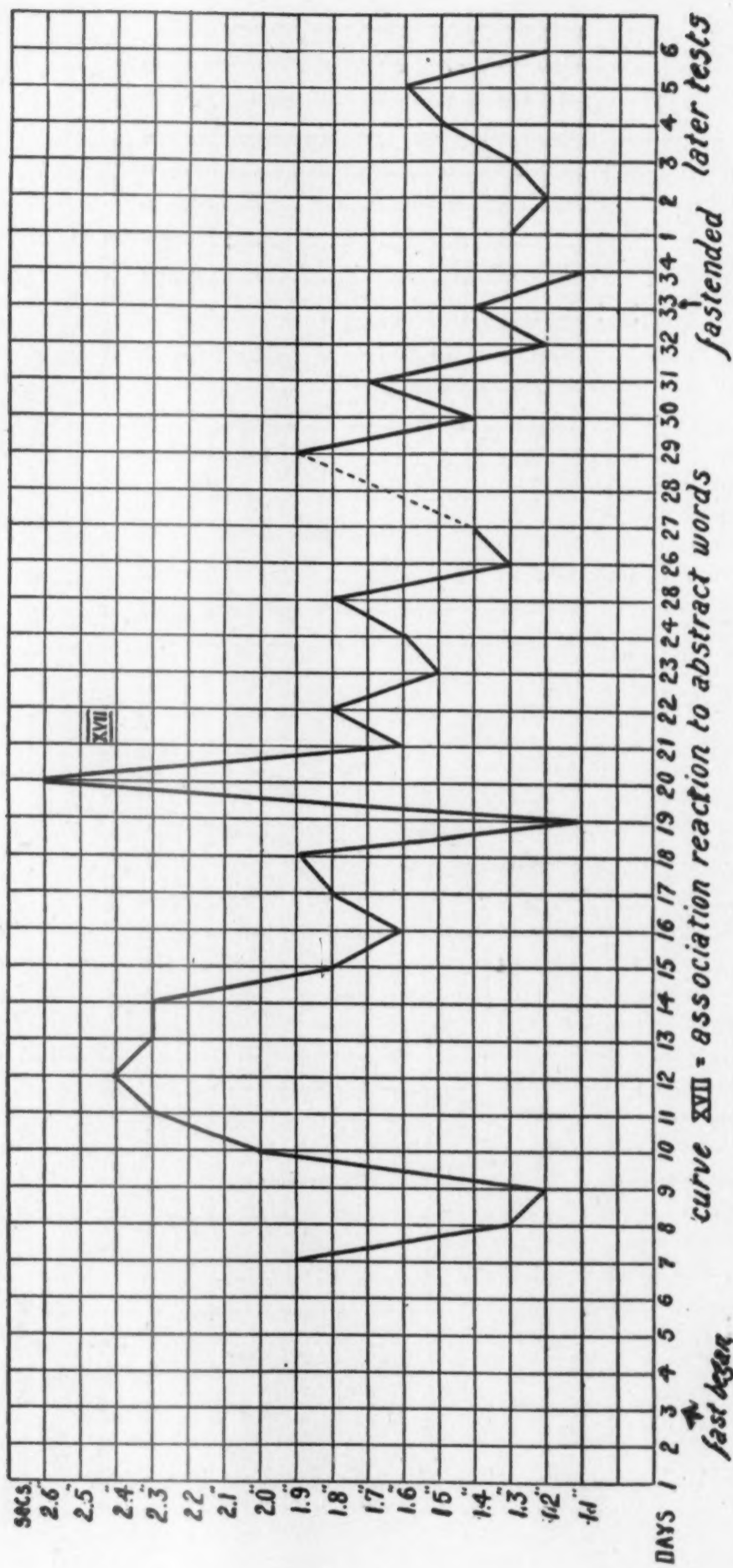
The curve begins with very long reaction times. Levanzin had never performed such tests before, so that the sudden drop on the 3rd day must be attributed to the practice improvement, which at this early stage could very well be sudden and of considerable amount, rather than to the fact that it is the first day of the fast. From this point the curve descends with a few breaks to the 15th day, when it reaches 1.4 sec. It then rises to the 22nd day when it reaches the maximum (if we do not consider the first few days) and then falls to the end of the series. On the second from the last day it reaches the minimum

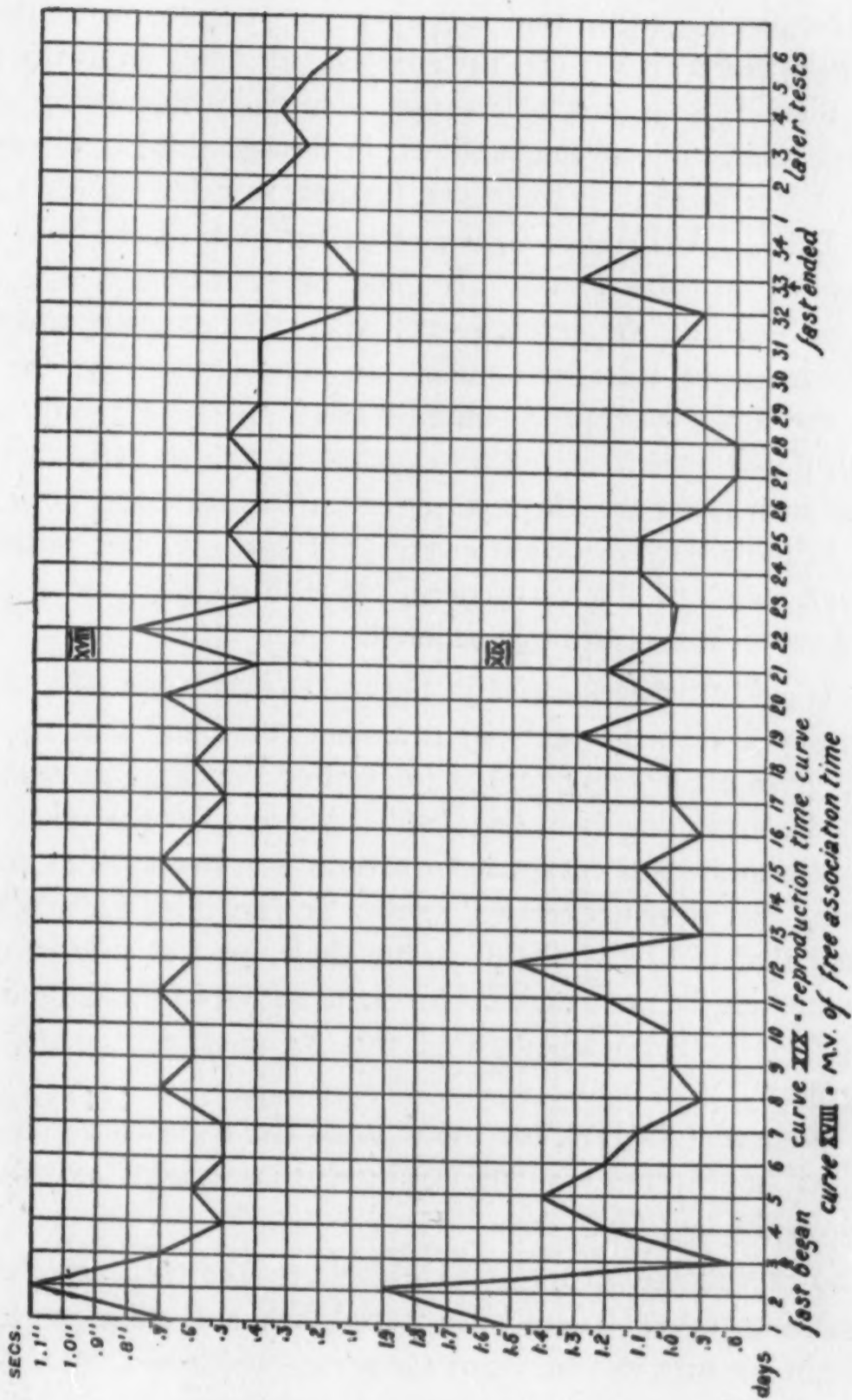
<sup>16</sup>The median which was also calculated gave the same general curve.











of 1.3 sec. Also the record of 1.4 sec. is obtained three times in the second half of the series. If we include the first few days it can be said in general that there is a very decided betterment in the association times; and even if one calculates from the third day there is an appreciable drop. Especially interesting is the almost steady improvement shown in the last third of the curve.

In order to analyse the curve further, separate curves (XIV, XV, XVI, XVII) have been plotted for each of the four categories of stimulus words. It must be remembered that these curves begin on the seventh day, when this division into separate categories was first made. In consideration of the fact that the daily average is obtained from only five reactions too much importance must not be attached to sudden daily falls and rises, such as in the abstract series on the 19th and 20th days and in the adjective series on the 18th day, etc., but rather the convex shape of the verb curve, the rise in the middle of the noun curve, etc., must be considered.

It is evident that the rise in the main curve about the 10th to 13th day is caused largely by the noun curve and that the relatively greatest improvement at the end of the curve as compared with the beginning is in the abstract curve. On the other hand the verb and noun curves have several low averages in the beginning that were not reached again. In fact it is hardly possible to say that either of these curves show general improvement, certainly not the noun curve. An examination of the daily fluctuations in the curve shows that this becomes less as the tests progress.

The curve (XVIII) for the m.v. of the main curve shows a decided improvement as the fast progresses with a very low level on the last three days.

The reproduction curve (XIX) follows the tendencies of the association curve. There is the initial drop and many more high peaks in the first two-thirds of the series. If it were not for the rise on the last two days the general betterment would be more marked. The reactions were, on the whole rapid, averaging about 1 sec. and dropping as low as .8 sec. As the number of false

| DAYS                  | FAST BEGAN |   |   |   |   |   |   |   | FAST ENDED |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | LATER TESTS |   |   |   |   |   |   |
|-----------------------|------------|---|---|---|---|---|---|---|------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-------------|---|---|---|---|---|---|
|                       | 1          | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9          | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 1           | 2 | 3 | 4 | 5 | 6 |   |
| False reproductions.. | 1          | 2 | 3 | 1 | 2 | 0 | 0 | 0 | 0          | 1  | 1  | 1  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 2  | 1  | 2  | 1  | 0  | 0  | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 2  | 1           | 0 | 0 | 0 | 0 | 1 | 0 |

**TABLE II**  
Classification of re-  
action words in as-  
sociation experiment.

[illegible]

**TABLE III**  
**Mistakes in cancella-**  
**tion test.**

|                     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|---------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Omissions .....     | 0 | 1 | 0 | 2 | 3 | 2 | 1 | 1 | 2 | 3 | 2 | 0 | 2 | 1 | 0 | 1 | 4 | 1 | 0 | 0 | 4 | 0 | 4 | 1 | 0 | 0 | 1 |
| Incorrectly crossed | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |

reproductions was very small (Table I), amounting to only twenty-three in 680 reactions or 3 per cent and never more than three in one list, an improvement or the reverse in this respect would mean little. At least one can say that the quality of the reproduction suffered no deterioration with the progress of the fast, but that retention was equally as good at the end as at the beginning.

The quality of the association reactions was of high grade throughout the main test (Table II). There were no senseless or pure sound reactions and very few repetitions. Synonyms, word-compoundings and misunderstood stimulus words occurred seldom and were scattered throughout the days. The word woman appears a number of times and man slightly less often. There was also evidences of a religious complex.<sup>17</sup> An examination of the different categories did not show sufficient change to warrant an analysis or tabulation as to quality. It was thought that the introduction of words designating food might produce delayed reactions both with the word itself and with the words immediately following. This was not the case. For example on April 16th we find egg-white 1.4 sec.: on April 19th omelet-eat, 1.4 sec.: on April 21st fish-sea, 1.4 sec.: on May 7th candy-sweet, .8 sec.: on May 9th apple-fruit, .8 sec.: on May 10th, roast-meat, 1 sec.: on May 13th chocolate-sweet, 1 sec. None of these reactions were followed by unusually long reaction times. It might be of interest to mention at this point the unusually long reactions which point to complexes. On April 13th we find pulse-hand, 9 sec.: on April 21st death-eternal, 22.4 sec.: and on April 26th uncertainty-pendulum, 12.6 sec. These are the only extremely long reaction times. The next longest is 6 sec. All of these delayed reactions may be explained from the same cause. Levanzin had asserted that the chief factor for a successful fast was faith and confidence and absolute lack of fear. He thinks it is the fear combined with exposure which causes death in shipwrecks and other calamities where food is not obtainable and not the actual lack of food. We also find that those who fast frequently cover their mirrors in order that they

<sup>17</sup> See for example the list of April 30th.

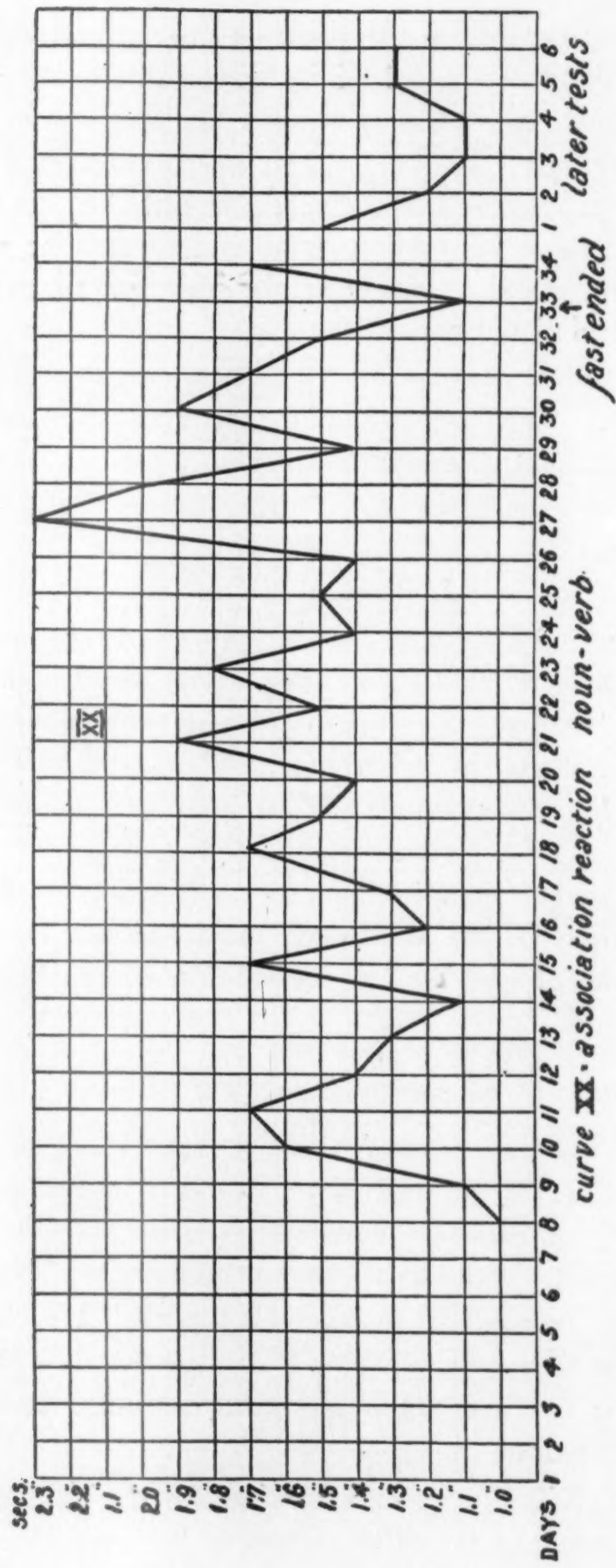
may not be disturbed by the evidences of emaciation. One of the further dangers in fasting is heart failure. If Levanzin's heart had shown alarming symptoms the fast would have been terminated at once. It does not, therefore, require a stretch of imagination to suppose that Levanzin would keep his mind from such subjects as death and uncertainty and that he would even avoid thought of the condition of his heart and that the mention of these words would cause hesitation.

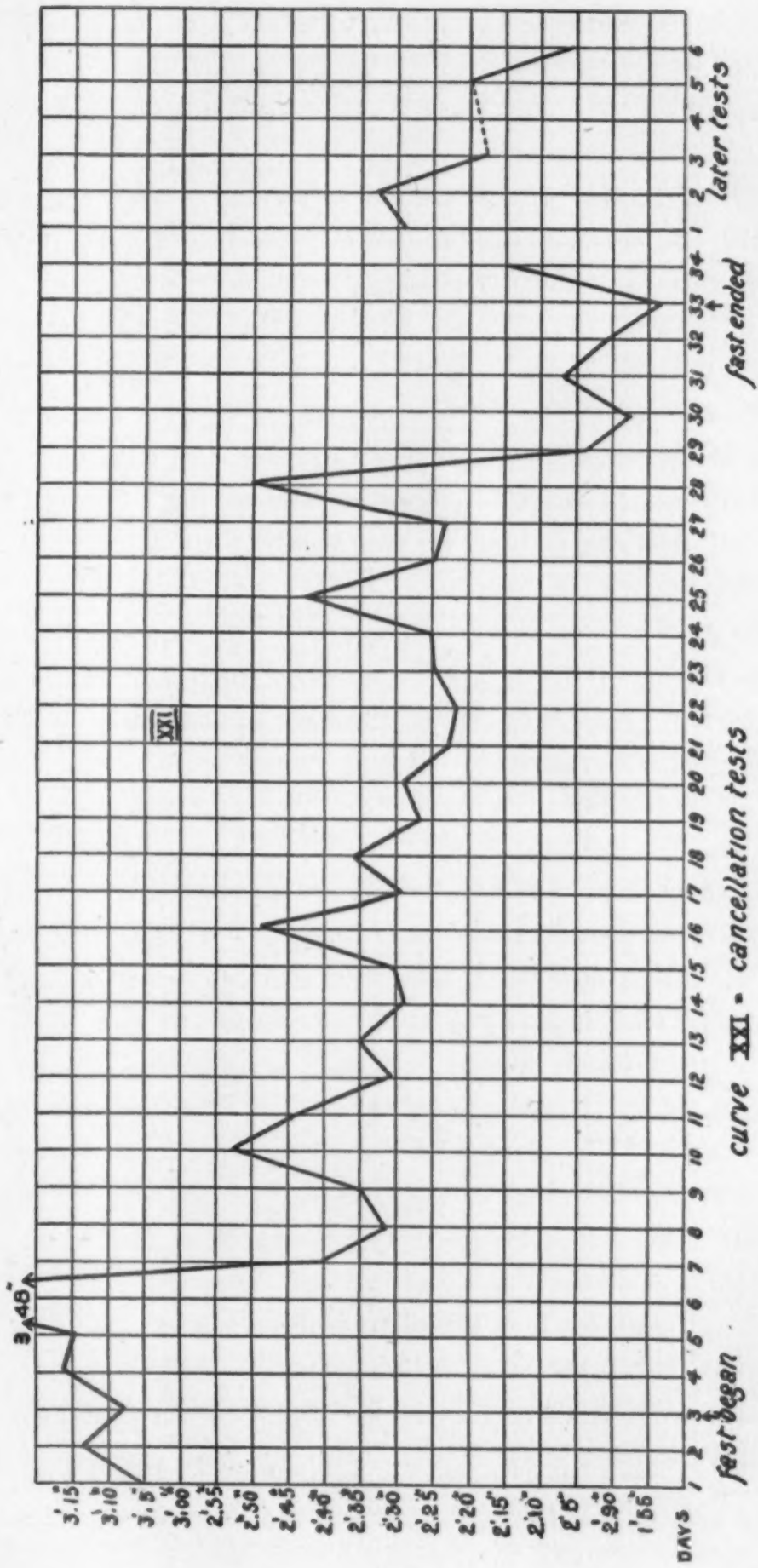
The determined association reaction noun-verb was begun on the 8th day. The curve (XX) resembles that of the verb curve, except that the rise continues longer. It starts very low,—1.0 sec.—increases with rather large daily fluctuations and on the last day of the fast returns to 1.1 sec. A particularly disturbing factor in this series was the fact that there was an ever increasing difficulty to obtain appropriate words. At first the words had obvious associations. They were names of common objects, such as dog, gun, eye, etc., but more unusual words had to be employed in increasing numbers and there seems no doubt that this circumstance was at least part cause of the increasing length of the reaction time. It is even more important in the determined than in the free association experiments to have the quality of the words the same and not more difficult. For long series of tests the free-association experiments are much to be preferred.

#### *Cancellation Test*

Special forms were made for this test consisting of type-written text of 100 a's and fifty of each of the other letters of the alphabet. A different combination was made each day so that the subject should not become accustomed to the order. Levanzin was requested to cancel all the a's. He used his left hand and the time was taken with a stop-watch. Special care was observed to have the illumination constant and the same pencil was employed.

The curve (XXI) represents the time for the completion of the task. As in some of the other curves so here we have the initial





rise, which continues to the 7th day, when there is a sudden drop to a level which slopes slightly to another sudden drop on the 29th day and a very low level for the final days. The difference between the maximum of 3 min. 48 sec. on the 6th day and the minimum of 1 min. 53 sec. on the 33rd day is very considerable. The maximum is over double the minimum and even if we compare the minimum with the initial time of 3 min. 7 sec. or with 2 min. 43 sec. of the 7th day which is the first and largest practice drop, we still find a very considerable difference. There does not seem any doubt therefore, that there is very much of a betterment in the time as the fast progresses and that this decrease in the time continues to the end of the series. Nor is this improvement in time gained at the sacrifice of accuracy. At no time were there many mistakes made (see Table III). In fact the degree of accuracy was always so high that we cannot place any importance on the slight increase of accuracy in the last half of the series<sup>18</sup> nor does the slight loss of accuracy at the minimum alter the significance of that result.

#### *Visual Acuity*

These tests were made in the large calorimeter room adjoining the small room in which the previous tests were conducted. The largest E which had been cut from the Schnellen test-card was used. This was held by the experimenter at the level of the subject's head when seated. It was illuminated by an electric lamp held by a second experimenter in front of the card and moved with it. The shades of the room were kept drawn during the experiment in order to have as far as possible constant illumination. The subject suffered from myopia and wore corrective glasses. A distance well within the threshold was first chosen at which the subject was asked to judge in what one of the four possible positions the E was being held. The experimenter put the card behind his back when he changed its position. After a few days of the tests it was thought that the subject might

<sup>18</sup> There were 29 mistakes in the first half and 24 in the second half of the series.

be using the secondary criterion of the distance of the edge of the E from the edge of the card, the E not being exactly in the middle. The card was therefore mounted on a larger card-board of the same color in order to obviate this possibility. On account of the surprising results both experimenters were at all times keenly attentive to the possibility of other secondary criteria, but none could be discovered. Ten trials were made at each distance, the card being moved from the observer in steps of one foot. That distance was considered the threshold which preceded the distance at which the subject made two mistakes out of the ten trials.<sup>19</sup> The alteration in the position of the E followed no definite order, but every means was used in this respect to confuse the subject in order to remove all possibility of his guessing the position. Most of the judgments were made without hesitation, both at the very low and very high thresholds.

The curve (XII) represents the daily threshold in feet. There is a very rapid rise from the 5th to the 14th day when the maximum of 37 feet is reached. Then there follows a drop to 24 feet and a rise to 36 feet on the next to the last day of the fast. The 34th day shows a drop to 19 feet. The record of the 5th day is 16 feet which is the minimum; that of the 32nd day is 36 feet, which is one foot less than the maximum. This difference of 16 feet is very great for visual acuity. He sees twice as far at the end of the fast as he does at the beginning.

#### *Later Tests*

Owing to an attack of colic resulting from the nature of the first food taken after the fast and the subsequent withdrawal from the laboratory it was impossible to continue the tests during the recuperative period, as had been planned. Only by later tests for comparison could a decision be reached as to the efficacy of fasting. One year after the tests just described Levanzin volunteered as subject for a short series of tests. These were conducted at the Harvard Psychological Laboratory and ex-

<sup>19</sup> Time prevented the threshold being taken in the reverse direction. The tests took five to ten minutes.

tended over a period of six consecutive days. It was not possible to arrange for them to take place at five o'clock as previously and ten o'clock in the morning had to be chosen. All the other conditions were observed as closely as possibly. The same tests with the exception of the visual acuity test and the hand-writing test were performed. Levanzin seemed in good health. He weighed about 126 lbs. which is somewhat less than he weighed when he began his fast. His physical appearance was, however, very much the same as on the day he arrived at the Nutrition Laboratory. He had remained in America during the previous year, engaged in medical studies, lecturing, etc., had not fasted again and had had no illness during that time. In coming to the laboratory he made a journey of four miles and had already had several hours work, having risen each day at five o'clock, exercised for half an hour and made several visits. The conditions previous to the tests are, therefore, hardly comparable to those of the former series. It is evident, however, that he was as strenuous if not more so than he had been up to the later hour of five o'clock of the previous tests.

The rote memory for digits (IIA) was somewhat poorer than it was during the latter part of the long series. It did not reach the maximum by two numbers, yet it did not show any poor scores. The curve (IIB) which represents the first mistake, or, as it was supposed above, the state of attention, shows an improvement over the latter part of the first series in that it does not drop as far. On the other hand the rote memory for words (IA) seemed as good if not better than during the fast. It reached the former maximum on the fourth day and never dropped below eight words. The memory after fifty-five minutes (IB) was as good as the immediate memory. From these results it may be concluded that the memory is still, after the year's interval, at about the level that it was at the end of the fast.

The curve (III) for the tapping begins considerably higher than the maximum of the fasting tests and although it drops somewhat, still it remains above the former maximum. The drop in the difference curve (IV) is caused principally by a

falling off in the initial spurt. This is concluded from the fact that the results of the last ten seconds vary much less than those of the first ten.

The results of the first day of the tactual space threshold cannot be used as a comparison (XI). The unusually high threshold was undoubtedly caused by inattention on the part of Levanzin, who admitted that he had been very much worried over an appointment he had been forced to miss and upon which his mind had been during these tests. Apart from this day the curve has the same form it had during the latter part of the previous trials. The second and third days show the minimum, which was last reached on the 30th day of the former trials.

The dynamometer used in the previous tests could not be obtained until the second day. There are, therefore, only five records. The curves for both the right (VII) and the left hands (V) begin with very high records and drop considerably on the second day, just as they did in the former series. These first records are very much better than any made in the previous trials. Even after the drop the right hand twice surpasses the previous maximum and remains close to it on the other days. The difference curves (VI, VIII) show that on the first day the high record for the left hand is made by a sustained effort. The right hand spurt causes fatigue toward the end. The large differences during the next three days for the left hand are caused by spurts followed by fatigue, that of the right hand by fatigue. It is seen that the strength of the muscles of the hand have very much increased since the end of the fast and judging from the first day's results is much greater than at the beginning of the fast. One acquires a knack in gripping the instrument and it may be that this is carried over from the former tests and makes these initial records higher than those of a year ago. In other words some of the effect of practice is still present and influences the results much more than it did when it had the opposing effect of fatigue.

The free association reaction time (XIII) begins at the low point of the last day of the previous series, on the third day it

reaches the shortest time of that series and again on the fifth day and on the last day it falls almost one-fifth of a second below this point. That is the curve continues the descent it began in the middle of the former series in as regular a manner as if a year had not intervened. Inasmuch as some practice is necessary after so long an intermission, it may be said that the reaction times are better than they were at the end of the fast. The m.v. (XVIII) was .5 sec. on the first day and .15 sec. on the sixth with an almost steady decline.

The average reproduction time (XIX) is .9 sec. for all the days. This is very low and although .8 sec. was reached three times in the former tests, it is safe to conclude that the reproduction times are at least as good as they were at the end of the fast. In fact the average for these days is better than for any six consecutive days of the previous tests. There was only one false reproduction and that was "wrong" for "bad." In view of the fewness of the trials little would be gained by an analysis of the results according to categories (XIV, XV, XVI, XVII). The noun and adjective curves are lower than the verb and abstract curves. The quality of the reactions is about the same. Evidence of a religious or mystic complex is as plain here as in the previous results. "God" was the reaction for "adore," "worship," "unseen," "mercy," "Divine," and "Infinite;" "supreme" gave "Being," "sacred" gave "church," "adorable" gave "saint," "life" gave "eternal," and "ornament" gave "church." There were no very long reaction times. In connection with the previous complex it may be mentioned that death was the reaction word for fear.<sup>20</sup>

The reaction noun-verb (XX) begins at the average of the 32d day of the former series and on the third and fourth day reaches the minimum of the next to the last day of the long series. The average of these days is very much better than that

<sup>20</sup> It was thought that a year's intermission would make the old lists equivalent to new ones and as one would then be sure of having the lists of this series of the same quality with those of the former, the old lists were used on the first day, but seven of the twenty reactions were the same as those made a year ago, so that new lists were made.

of the last days of the fast series or even of the first days so that there is no doubt of an improvement in these reactions.

The cancellation test (XX) begins at about the point of the 27th day and the time gradually decreases, but at the sixth day has not reached the rapid time of the 33rd day. Judging from the slope of the curve one would expect it to do so shortly, however, so that one can conclude that the mental functions necessary for this test, are in about the same state they were at the end of the fast. There were only six mistakes, four of them being on the first day.

### *Correlations*

It would be supposed that there should be very good and very poor days upon which all the curves would show proportionate increases or decreases or that at least similar tests, such as those of the higher mental-processes, would show similar variations. If we compare some of the crests and valleys however, we arrive at negative results. For instance, on the 22d day the association time (XIII) is long and both memory curves (IA, IIA) are in a valley, but the cancellation test (XXI) shows improvement, and the reproduction times (XIX) are not long. On the 16th day the left hand reaches a maximum in the strength tests (V), but the right hand (VII) shows no such result. Tapping (III) rises on that day, but it is still comparatively low, one memory curve has fallen (IIA) and the association time (XIII) has risen. On the 15th and 17th days the memory curve (IIA) is at a maximum and association time (XIII) is also lower, the cancellation test (XXI) is also low on these days, but the maximum of the memory tests (IA, IIA) on the 31st day finds the association times (XIII) longer. On the 12th day the curves for the strength tests (V, VII) have risen for both hands—it is the maximum for the right hand—the time for the cancellation tests (XXI) has shortened and memory (IA) is better, but the tapping record (III) has fallen and both association (XIII) and reproduction times (XIX) are at a peak. The considerable lengthening of the time of the cancellation

test (XXI) on the sixth day finds a betterment in most of the other tests, the tapping test (III) indeed, having reached its maximum on that day. The visual acuity curve (XII) rises abruptly to its maximum on the 14th day and although with a few exceptions the curves show a slight betterment, the rise is comparatively insignificant.

It must be concluded, therefore, that with the exception of this last day the daily fluctuations cannot be traced to any one cause such as a general bodily fatigue and depressed mood or vigorous and cheerful mental states, but that either there is a change in the one or more processes essential to the particular test that is showing the exceptional rise or fall or that there has been a momentary wave of fatigue or distraction or spurt, etc. A diary of the fast was kept in which every important incident was noted and it is possible that many of the fluctuations in particular curves or changes in general tendencies of several of the curves could be more or less satisfactorily explained. The following considerations, however, make such explanations of doubtful value. One cannot say in advance what the effect of visits or other changes in the general routine may be. Much depends upon the particular circumstances. Now if the results were better after a certain visit one could say that the subject was in a pleasant mood after the break in the monotony of the days and that his mind had been stimulated by agreeable conversation. If the results were worse on those days one could say with equal weight that the fatigue following the unusual exertion was the cause. Only the most reliable introspection on the part of the subject before and after each test could have given strength to such explanations and both the lack of time and training on the part of the subject made such a procedure impossible.

It did seem possible, however, to make an exception of the days that Levanzin took a drive or was allowed on the roof and that if the curves showed an agreement in their fluctuations on these days an unequivocal explanation could be found. The drives were taken on the 14th, 17th, 20th, 22nd, 24th, 29th,

31st and 32nd days; the visits to the roof on the 11th, 15th, 21st and 30th days. As was stated above there was no general agreement even on these days. In regard to the individual curves, however, the visual acuity curve seemed to show the influence of the drives. The best result in the visual acuity test was made on the first drive day and the curve always ascends on the drive days, although not always to a peak. It falls, however, on all but one day when a visit was made to the roof and that it rises on the drive days is contrary to what one would expect and is difficult of explanation, since the subject's eyes should if anything have been fatigued by the increased light. If there had been a stimulation of the central processes causing a heightened power of discrimination, this ought to have influenced the other curves as well.

#### *General Summary and Conclusions*

The fact that a human being could live for a month or longer without food had already been satisfactorily proven.<sup>21</sup> In recent years Merlatti is reported to have fasted for fifty days and Dr. Tanner for forty days. The fast of Succi<sup>22</sup> is most similar to that of Levanzin in that it was undergone for about the same length of time and under similarly strict scientific control, although never before had quite so many precautions been taken as in the case of Levanzin. Succi fasted for thirty days, but took pepton on the 27th day. Levanzin continued for one day

<sup>21</sup> E. Bardier in his article "La Faim" (Ch. Richet's Dictionnaire de Physiologie. Vol. 6, p. 3) remarks in regard to voluntary and involuntary fasts: "on pourra se soumettre volontairement à un jeûne prolongé, comme l'expérience en a plusieurs fois été tentée, et endurer assez facilement les souffrances de la faim. Le besoin de manger sera d'autant moins douloureux, d'autant plus facile à supporter qu'il suffira d'un signe pour être mis en face d'un succulent repas. Au contraire, la faim sera beaucoup plus pénible ses manifestations beaucoup plus douloureuses, si l'on se croit-dans un naufrage, dans une expédition,—voué à une inanition complète sans espoir de salut." On page 6 in reference to forced fasting he further says: ". . . la lutte que l'on est obligé de soutenir contre les causes mêmes de cette inanition augmente la sensation de faim."

<sup>22</sup> Das Hungern, by Luigi Luciani. Translated into German by Dr. M. O. Fraenkel. 1890.

longer, absolutely nothing but 750 cc of distilled water passing his lips during that time. Both men remained in good physical condition throughout and seemed at no time to suffer any unusual discomfort. It was with difficulty that Levanzin was persuaded to discontinue his fast on the 31st day. Although Luciani doubted that Succi was mentally normal, general observations and the tests pointed to a sound mind in the case of Levanzin. Both men were, naturally, men of great determination and above all of implicit faith and confidence in their idea. Levanzin believed fasting to be a panacea for all ills and the very fact that he is of that type of man who can narrow his horizon about an idea and stubbornly resist all invasions, gave him the best equipment for the fight against the natural demands of the flesh. Such a type of mind cannot be called abnormal, although it is unusual. The feeling of hunger was at all times even during the first stages of the fast denied by Levanzin. This statement should not be disbelieved even though the general experience of most men is extreme discomfort, which those who fast tell us only disappears after the second or third day as in the case of Succi. With Levanzin and perhaps with other fasters this feeling of hunger may have been suppressed from the beginning by autosuggestion. The fact of the deep ingrained faith in the fast makes this plausible.<sup>23</sup>

The condition of Succi's higher mental processes was only ascertained by general observation. These agree with those upon Levanzin. There was at no time any symptom of hallucination or lack of clearness in the thought processes. Luciani writes:

<sup>23</sup> E. Bardier, in criticising Bernheim, writes: "Au sens où l'entend Bernheim, les jeûneurs qui se soumettent à l'inanition résistent facilement, tout simplement par le fait d'une auto-suggestion. Discutant en particulier le jeûne de Cetti, il admet que ce dernier tout en n'étant pas un hystérique—s'est suggestionné. Il demeure convaincu qu'il conservait toute sa force physique, 'cela suffit pour réaliser le phénomène; l'idée fait l'acte; il s'exalte, il s'entraîne, il se nourrit de son idée, il se montre avec complaisance à ses visiteurs, il jouit de son triomphe; l'esprit domine le corps; etc.'..... Le jeûneur, par sa volonté, arrive à résister à l'habitude de manger; il obéit à sa conscience qui le soumet à l'abstinence, mais certainement sa volonté doit être incapable de provoquer la suppression d'une sensation." *Op. cit.* p. 10. See also footnote p. 3.

"Am 13 Hungertage wollte ich seine Ausdauer bez. geistiger Anstrengungen auf die Probe stellen, indem ich ihm schwierige oder unlösliche metaphysische und theosophische Fragen vorlegte und beständig Einwürfe gegen seine Antworten erhob, in der Absicht, seinen Verstand zu ermüden. Ich muss gestehen, nicht bemerkt zu haben, dass sein Geist dabei mehr ermüdete als der jedes andern Sterblichen von gleichem Bildungsgrade und gleicher Begabung, wenn man ihn solchergestalt martert."<sup>24</sup> Levanzin is a man of a much higher level of intelligence and intellectual training than Succi. At all times during the fast he was very eager to enter into discussions upon abstract subjects such as the value of the Esperanto language, the political conditions in Malta, the possibility of mental telepathy and theories of spiritism as well as the value of fasting. It could not be observed that there was any diminution of his argumentative powers or lack of lucidity of expression. When aroused to counter argumentation he showed the same energy in reply at the end as at the beginning of the fast.

Succi's muscular strength as well as his sensory acuity was ascertained in a manner somewhat similar to the method employed for Levanzin and the results will be compared in the following summary and interpretation of results:

1. In the Dynamometer tests made upon Succi it is impossible to tell from the text how many trials were made daily. As the curves for the ten trials and for the initial trial for Levanzin are similar, the ten trial curve will be considered. It is safe to assume from lack of mention of the fact and from the nature of the curves that Succi was right handed. It will therefore be necessary to compare the curve of the right hand of Succi with that of the left hand of Levanzin.

It will be remembered that the strength of both hands was found to increase after the drop on the second day until the right hand (VII) reached its maximum on the 12th day and the left hand (V) on the 16th day, both curves then dropping steadily from this point, the right, however, less than the left,

<sup>24</sup> Op. Cit. Pp. 68-69.

for the left reached a minimum on the 31st day, while the right during the fast never dropped as low as the record of the 19th day. There is a very striking similarity between them and Succi's tests.<sup>25</sup> Both of Succi's curves also drop after the first trials and then rise again, his left reaching a maximum on the 14th, his right on the 20th day, as compared to the 12th and 16th days of Levanzin. Succi's curves then drop also, but the left drops more than the right which is the reverse of Levanzin's curves. With Succi both maximums are greater than the first day's records while with Levanzin this is only the case with the left hand. This agrees, however, with Levanzin's records for the initial daily trials (IX, X). Further Levanzin was able to make a spurt at the end of the fast with both hands, this spurt extending through several days. Succi was only able to spurt with one hand and that on the last day, the curve for the other hand remaining stationary.

Luciani attributed the rise of the curve alone to autosuggestion. It seems quite probable, inasmuch as both men believed that their strength would be increased by the fast, that this idea strengthened their determination and that they bettered their results by sheer "will power."<sup>26</sup> There is, however, another possibility which may be assumed without denying the influence of autosuggestion and that is that at least in the case of Levanzin, who was unused to such tests, the coördination of the muscles became gradually more perfect and further that these muscles, which were being exercised daily increased for a time in strength as they would have done under normal conditions, but in this case possibly to the detriment of other muscle groups. In both cases with both hands fatigue gained the ascendancy over practice effect and possibly over autosuggestion about the middle of the fast, causing the curves to drop. In the case of Levanzin's unpracticed hand, however, the effect of

<sup>25</sup> Op. cit. p. 55.

<sup>26</sup> E. K. Strong, Jr., in his paper entitled "The Effect of Various Types of Suggestion upon Muscular Activity" (Psych. Rev. 1910 Pp. 278) says: "The auto-suggestion tends most strongly of all the types of suggestion to heighten the maxima."

practice had more room to work and held the curve up longer than in the case of the practiced hand.

2. The tapping test (III) is also influenced by the condition of the muscular tissue, but there is another factor more essential here than strength and that is the reaction time. As in the strength tests so here there is a rise at first, but here it is of much shorter duration, the maximum of 215 taps in 30 seconds being reached already on the sixth day. The following considerable drop until the 15th day, at a time when the strength tests are showing more efficiency, may possibly be caused by a lessening in the interest for this test.<sup>27</sup> About the middle of the series this interest and increased effort for a good record may have returned, judging from the results, but fatigue had by that time set in and the curve, although rising until the last day is never quite able to reach the maximum of the sixth day; that is, there was some falling off in the rapidity of reaction, which judging from the results of the strength test is due rather to a change in the muscle tissue than to a change in the nervous arc.<sup>28</sup> From what we know of the effect of practice in such tests it is most probable that if it had not been for this increased muscular fatigue the curve would have reached an appreciable maximum at the end of the series. From the fact of the very

<sup>27</sup> See pp. 7 and 9.

<sup>28</sup> As the tapping tests preceded the strength tests the objection can not be raised that the hand was being unusually fatigued by these latter tests.

In reference to the tapping test under normal conditions Wells writes that "The objective fatigue phenomena which we note in the test are in all probability fatigue phenomena in the refractory phase or a lowered efficiency of coördination, equally a product of altered synaptic conditions; the sensations of fatigue on the other hand, may with squal assurance be ascribed to tissue changes within the muscles that take place as a result of their continued effort." (F. L. Wells. *Normal Performance in the Tapping Test before and during Practice, with Special Reference to Fatigue Phenomena*. A. J. of Psych. 1908, p. 473.) In the above tests the change in muscular tissue is due to emaciation, a fact that does not play a rôle in the test to which Wells refers. At no time did Levanzin speak of sensations of fatigue and judging alone from his facial and bodily expressions there is no data from which to assume that they were greater at the end than at the beginning of the fast. As to the synaptic conditions there is nothing in the test to point to a change.

small difference between the average of the first ten and last ten seconds on the sixth day when the maximum was reached, as compared with the great difference in the almost equally good result of the last day, it is evident that on the first day the good performance of the first ten seconds practically continues throughout (in both instances the best record was made during the first ten seconds) while on the last day the effect of practice as shown in the initial performance was counterbalanced toward the end by fatigue.<sup>29</sup> These results seem to cast further doubt upon Luciani's hypothesis of autosuggestion in the strength test, for surely autosuggestion should play as great, if not a greater, rôle in the tapping tests during those days in which according to the strength tests it would have to be assumed at work. The results of the tapping test are indeed directly opposed to such a theory.

To sum up it may then be said that although initial lack of interest and later muscular fatigue played a rôle, both factors being directed toward a decrease in the amount of work, yet the nervous impulse toward the end was sufficiently great to bring the curve back to its initial level and almost to its maximum.

3. The threshold for tactual space perception (XI) decreased somewhat as the fast progressed. It was on the average much better during the last half than the first half of the series. Similar tests were made upon Succi upon a number of different parts of the body, but only on three days, before the fast, on the 15th day and on the 29th day. On some parts of the body there was an increase on other parts a decrease. Luciani believed the difference in the three days due to differences in degree of attention. On that part of the body corresponding most closely to the spot used in these tests i.e. the lower third of the volar side of the forearm, there happened to be a rather large decrease in the threshold, the three thresholds being respectively 16, 11 and 10 mm.<sup>30</sup> Authorities differ as to whether practice lowers

<sup>29</sup> Wells writes "the true practice gain is one mainly in the initial efficiency of performance, as distinguished from the warming up gain, which shows itself chiefly in continued efficiency of performance." *Op. cit.* p. 478.

<sup>30</sup> *Op. cit.* p. 64.

the threshold in tests performed under normal conditions. Dresslar<sup>31</sup> for example, found that practice had a considerable effect. Solomon<sup>32</sup> found that if the subject is not informed of his errors there is no effect of practice. In the above tests the subject was never told of his mistakes and "vexier" trials were introduced at frequent intervals and in no special order, yet there was a lowering of the threshold. This may and probably is due to several causes. A physiological cause would be a decrease in the fat thus exposing the nerve endings and making them more sensitive. On the psychological side increased attention, which we find indicated in other of the tests would lower the threshold for discrimination. Also as the tests progress the image of the criterion used becomes cleared. From what is known of the process of perception, this is a most important factor in explaining the above effect of practice. The physiological change is the only one which could be attributed unequivocally to the fast. The central change occurs in series under normal conditions.

If, as has been often assumed, the tactual space threshold test is a measure of mental fatigue, then it must be concluded that there is no indication of such fatigue during the fast.

4. The visual acuity (XII) showed an astonishing betterment. From 17 feet as the distance of clear vision for the particular test card employed, the curve ascended rapidly to 37 feet on the 14th day and, although there is a falling off, 36 feet is the record for the last day of the fast.

If it were not for the maximum of 37 feet midway in the series, the improvement would be comparatively a steady one. One explanation that suggests itself is that the possible change in intra-ocular tension caused the eye-ball to change its shape. Unless his glasses were not the proper ones for him, however, a change in the eye should cause more rather than less difficulty as long as he wore his glasses. Further the suddenness of the

<sup>31</sup> F. B. Dresslar. *Studies in the Psychology of Touch*. A. J. Psych, pp. 313-368. 1894.

<sup>32</sup> L. M. Solomons. *Discrimination in Cutaneous Sensations*. Psych. Rev. p. 246-250. 1897.

rise seems to vitiate such a theory. A satisfactory explanation seems difficult to find. It might be said that the 37 feet record was made by chance. This also seems precluded by the fact of the number of previous steps in which 10 correct answers were given and from the evidence of confidence displayed by the subject.<sup>33</sup>

Succi's eyes were examined with the ophthalmoscope and his acuity measure before the fast and on the 15th and 28th day of the fast, but no change was detected.<sup>34</sup> If Levanzin had happened to be measured on the third, sixteenth and one of the days toward the end of the series only, the change would have been thought as negligible as in the case of Succi. In all such tests where the daily fluctuation is considerable three tests in a month are not sufficient upon which to base a judgment as to the change in sensory acuity or higher mental processes.

5. The rote memory for digits (II) showed very little change. There is a slight suggestion of improvement during the first half of the series. Judging from the curve which indicates the point at which the first mistake was made (IIB), one can say that there was a gradual improvement in this respect, especially in the first half of the series, which is probably in part due to a betterment in the perception of the spoken word, but especially to an increase in attention, it becoming more sustained as the fast progressed. The rote memory for sense words (IA) showed a greater improvement than did that for digits. Here probably the practice effect consisted in the forming of associations between the words. The most marked improvement of all is in the retention after a longer period of time, i.e. after 55 min. (IB). This is probably also due in part at least to the more frequent forming of associations. In addition the repeti-

<sup>33</sup> The subject did not know whether he was right or wrong or how many correct answers constituted a threshold, so that the results could not have been prearranged by him. And if they could have been he would not have allowed such a good record already on the 14th day. The high threshold on the last day is obviously due to his unusually poor physical condition (when if at any time one might be justified in speaking of a lack of effort).

<sup>34</sup> *Op. cit.* pp. 66-67.

tion of the same task through so many days undoubtedly strengthened the determining tendency, i.e. the determination taken at the time of memorizing for the words to appear in consciousness again, it remaining either in consciousness or sub-consciousness during the interval. According to Levanzin's statement his mind did not revert to the task within the hour.

Experiments upon memory under normal conditions also show the effect of practice as evidenced by an appreciable increase in the memory span which may continue for a period of two months.<sup>35</sup>

6. The Cancellation test, (XXI) which employs to a greater degree the higher functions of perception and attention shows the greatest improvement of any of the tests used. This improvement continues from the sixth to the last day of the fast. The accuracy is so high throughout the series that the slight improvement in the latter part of the tests is of no significance. Experiments have shown that fatigue affects the accuracy, so that again we have evidence against an increase in mental fatigue.<sup>36</sup>

Besides an improvement in the above named functions, the increase in visual acuity may have been a factor in the results. On the other hand, from the results of the tapping-test and strength tests one must conclude that the betterment is in no degree due either to a betterment in reaction time or motor ability.

7. The free association time (XIII) is on the whole shorter during the latter part of the series. If it were not for a rapid drop in the middle of the curve after a rise similar to that in the

<sup>35</sup> T. L. Bolton, The Growth of Memory in School Children. A. J. of Psych. 1892, pp. 362-380.

G. Müller & F. Schumann. Experimentelle Beiträge zur Untersuchung des Gedächtniss, Zeit. für Psych. 6. 1894, pp. 81-190, 257-339.

W. H. Winch. The Transfer of Improvement in Memory in School-Children. B. J. of Psych. 1908, pp. 284-293.

<sup>36</sup> B. Bourdon. Observations Comparatives sur la Reconnaissance, la Discrimination et l'Association. Rev. Phil. 1895, pp. 153-185. A. Binet. Attention et Adaptation, Année Psych. 1900, 6. Pp. 248-404. C. Ritter. Ermüdungsmessungen, Zsch. für Psych. 1900, pp. 401-444.

tapping-test the improvement would be comparatively steady. The minimum of 1.3 sec. is reached on the day before the last day of the fast and should be compared rather with the 1.9 sec. of the third day than with the 2.5 sec. of the first day, when Levanzin was unaccustomed to the manner of reaction. Even when this comparison is made it is seen that the improvement is considerable. A separation of the curve into four curves corresponding to the four categories used, made a more minute analysis possible. All the curves (XIV, XV, XVI, XVII) show fewer high averages in the second half of the series, but it is only in the abstract curve and in less degree in the adjective series that there are more low averages in the second half of the curve. In fact in neither of the other two curves is the lowest average of the first half of the series again equalled. This seems to indicate that the betterment in the general average of the twenty words is principally due to a betterment in the reaction to abstract words. It is to be expected that the most difficult associations would show the greatest practice effect. In the noun and verb curve there is an almost steady rise in the middle of the curve corresponding to the rise in the middle of the main curve. It seems plausible to suppose that there is here as in the tapping test a falling off of interest and that this would manifest itself more readily in the easier tasks, where the reaction is likely to become more nearly mechanical.

The general improvement is also seen in the decrease in the variations of the reaction times. In all four curves the daily variation is much less in the second half of the series. Parallel with this is the decrease in the variations within each day, as is shown by the decided drop in the m.v. curve (XVIII).<sup>37</sup>

Although the improvement in the reproduction time is not as great as in the association time yet it is noticeable, the average of the second half being lower than that of the first, although

<sup>37</sup> Wells conducted long series of association reactions with normal subjects and for all of them found an improvement in the reaction time. "Practice Effect in Free Association," *Am Jour. of Psych.* 1911. Vol. 22, pp. 1-13.

the very low time of .8 sec. was made on the second day as well as during the second half of the series.

The quality of the associations was good throughout, (Table II) and showed no striking change.<sup>38</sup> The reproductions were so nearly perfect from the first that nothing can be said in regard to them to support the results of the memory tests. One might add, however, that neither do they contradict those results.

The controlled reaction noun-verb (XX) shows an increasing lengthening of the time until almost the end of the series. It is quite probable that this was caused by an increasing difficulty in the stimulus words selected, a factor which could not well be avoided. No other reason suggests itself why these reactions should have taken a different course from that of the free association tests.

The present methods of testing mental capacity unfortunately do not permit one to make dogmatic statements as to the results of any such tests. In each one a number of functions are involved any one of which may have produced the variations which occur. For example in the cancellation test there is involved among other things attention and interest, apperception and discrimination, nervous impulse and motor discharge. When, however, as here, a set of tests are employed in which the same

<sup>38</sup> W. Weygandt's results are hardly comparable to those obtained in these tests (*Ueber die Beeinflussung geistiger Leistungen durch Hunger*, *Psych. Arbeiten*, 4, pp. 45-173). His subjects fasted for periods of only twenty-four and forty-eight hours at a time. This intermittent fasting seems to cause a much more pronounced disturbance to the organism than a prolonged fast. That there was greater exhaustion seems to be indicated by the fact that there was an increase in the associations by sound. He also finds that there was an increase in the outer as compared with the inner associations. (It is now admitted that such a classification of reaction words cannot be made without introspection.) Weygandt also found memory to be effected. The association time was not altered. Aschaffenberg studied the effect on association reactions of the exhaustion produced by a night's work without food or sleep. (*Studien ueber Associationen*, II Teil. *Die Associationen in der Erschöpfung*. *Psych. Arbeiten*, 2, pp. 1-83.) He too found a similar decrease in the quality of the reaction words. "Mit der Zunahme der Erschöpfung wirkt die zugerufene Vorstellung immer weniger durch ihre Inhalt; an dessen Stelle bestimmen der Klang und die Tonfarbe die Reaction."

functions are more or less active and they all show a similar trend, then a conjecture along general lines seems legitimate. And further when there is a very decided difference and it is known that a certain function is of prime importance then one is undoubtedly justified in ascribing the outcome of this test to changes in this function. It is desired to make it plain that no exact measurement is claimed, but merely that it has been possible by means of a number of selected tests to sketch an outline picture of the condition of Levanzin's psychophysiological organism.

It will be remembered that the tests range from those involving principally the muscle groups to those depending in a higher degree upon central factors. The tests depending most on the muscular reactions i.e. the strength test, showed a falling off. The tapping test which also involved the muscles but in which the rapidity of reaction was a more important factor showed no improvement. As soon as one turns, however, to the sensory discriminations one notices an increased efficiency, which is probably due either to a change in the peripheral organs, or central processes or both. Finally all the tests involving the higher processes of attention, perception and association show improvement. *In a word there was a loss in muscular strength due probably to loss of tissue, a possible gain in sensory acuity and a decided increase in the efficiency of all the central processes.* It would be premature to say that the improvement is the direct result of the prolonged abstinence from food, in as much as similar improvement has been observed in such tests under normal conditions due entirely to the effect of practice. *It can be stated, however, with some degree of certainty that the complete abstinence from food for thirty-one days had little effect upon the higher mental functions which were able to develop through practice very much as they would have done under normal conditions.* This agrees with the observations upon the physiological conditions. It has been found that during a fast the muscle tissues are the first to suffer and the nervous tissues the last. From these results it seems that up to the thirty-first day the nervous tissues have not suffered.

These results also confirm in part the general observations made by those fasting. It is frequently stated by them that they can do better mental work. The results show that at least they can do approximately as well, and it is not at all unlikely that some can do better, for it must be remembered that there is none of that sluggishness of the mental processes directly after eating, when the digestive processes are at their height and there is also absence of indigestion and the after effects of alcohol, caffeine and tobacco. That, on the other hand as has been often claimed, they are able to do more muscular work and that their power of endurance is greater is in this case at least not true. Probably the contrast of their actual results compared with what they expected would happen to a man without food makes the result seem greater than it is. The claim that the senses are more acute has been verified as to the visual acuity. It is hardly likely that the slight difference in the tactile space threshold would have been noticed by the faster.<sup>39</sup>

The question remains as to whether prolonged fasting is beneficial or dangerous to the organism. This can only be satisfactorily answered after an exhaustive physiological examination extending over a long period of time subsequent to the fast. The tests made after the lapse of a year permit, however, of some conjecture in this regard concerning those functions at least which have been discussed in this paper.

The strength test shows a great improvement over the former record. Levanzin exerted a pressure considerably greater than at any time during the long series. The record for the tapping test is also above the maximum of the previous record. The association test shows a marked improvement and the reproduc-

<sup>39</sup> Levanzin stated that the heightened sensitivity for odors made walking on the streets of Malta during his first fast positively unpleasant.

The other senses were examined in the case of Succi and no appreciable change discovered. *Op. cit.*

Whipple, *op. cit.* p. 215, in speaking of the effect of practice in the aesthesiometer test remarks that Dresslar states "this practice effect is . . . rapidly lost, being reduced very definitely within eight days and completely lost within a month.

tion is also better, especially in that it varies less, and the retention of sense words has perhaps also slightly improved. The tactual space threshold and the rote memory for sense words are about the same as at the end of the fast. Only in the case of the memory for digits and in the cancellation test has the previous maximum not been reached, but both of these results show consistently good results. It may be stated in short that after an entire year's intermission the curves continued practically from the point they had previously reached if not considerably above that point without showing that loss of practice which might well have been expected. These improved conditions are, however, not necessarily traceable directly to the beneficial effects of the fast. In regard to the association tests Levanzin has undoubtedly become still better acquainted with the English language and in respect to the strength tests it must be noted that Levanzin has exercised his muscles daily according to his report. In general he has lead a careful life paying especial attention to his diet. There is also the possible effect of climate and his new surroundings with which to reckon. Finally and most important is the possibility that there was actually a greater effect of practice in the first series than appeared in the records but that it was concealed by certain opposing effects of the fast, so that the results of the later tests may not be quite what might be supposed from a comparison of the records.

It remains, however, an undisputable fact that, according to the tests made there was no lasting evil effect of the fast, either upon muscular strength or mental activity and that from one cause or another Levanzin was, if not in better condition, certainly in as good health after as before the fast.

The author takes this opportunity to express his appreciation of the kind assistance of Dr. F. G. Benedict, Director of the Nutrition Laboratory and of the advice in the selection of the tests given by Professor Raymond Dodge. Thanks are also due to Mr. Carpenter and the other members of the Laboratory for their ever ready aid.

## APPENDIX I

### *Dreams*

As has been already stated Levanzin was asked to recount the dreams he had had during the previous night. From these records those dreams are here given which pertain to food. It will be seen that at one time he ate, at another refused food, but in neither case was there evidence of anything but a normal emotional reaction. According to the Freudian theory this absence of an intense emotional state (there were no nightmares nor anything else in the records indicative either of mental or bodily distress) means that the will ("wish") to fast was too strong to allow of any serious conflict of ideas. A great part of the dreams are of a sexual nature and are not here given.

April 13th. I saw a basket covered with a white piece of cloth, which I imagined full of food. When I tried to uncover it several black rats jumped out of it and frightened me.

I dreamed I was passing down one of our streets in Malta with a paper bag under my arm containing cheese cakes for my daughter. I found myself in a state of mental excitement and after going a certain distance I found that the lower end of the bag was opened and the cheese cakes were gone. In their stead was a white hand.

April 19th. I dreamed I was in a shop and on the counter there was a very big ham of about ten feet diameter. The proprietor was riding on the top of it with a knife in one hand. "It is a very good one," he said. I answered, "I do not like it. Do you not know I am fasting?" Then a Friar came in and said, "I will take it in his stead, because I like it." He took it and swallowed it.

April 21st. I dreamed I had been for a walk in the country. I went to a country tavern and asked for something to eat. He gave me a beefsteak and some fried red fish. I ate them with relish and asked what I had to pay. He told me \$1.50 and asked if that was too much. I said I did not think so. In coming out of the tavern I saw a river full of these red fish and people were trying to catch them. I said, "You are fishing out all the fish and if you continue you will not have any more to eat."

# APPENDIX II.

April 11, 1912

| Stimulus<br>Word | Reaction<br>Word | Reaction<br>Time |
|------------------|------------------|------------------|
| Paper            | ink              | 2.2              |
| Bright           | light            | 2.               |
| Yellow           | lemon            | 1.8              |
| Table            | knife            | 1.2              |
| Spoon            | broth            | 2.8              |
| Apple            | stem             | 2.4              |
| Sleep            | bed              | 1.6              |
| Room             | door             | 1.3              |
| Face             | eye              | 2.0              |
| Carpet           | red              | 1.8              |
| Animal           | white            | 2.6              |
| Rain             | noise            | 5.               |
| Teach            | bench            | 2.               |
| Doctor           | knife            | 4.               |
| Book             | no. of pages     | 3.8              |
| Store            | glass window     | 1.6              |
| Horse            | tail             | 2.2              |
| Island           | trees            | 2.2              |
| Journey          | ship             | 2.2              |
| Freedom          | banner           | 2.0              |
| Sweet            | sugar            | 1.2              |
| Average          |                  | 2.3              |

April 13

| Stimulus<br>Word | Reaction<br>Word | Reaction<br>Time |
|------------------|------------------|------------------|
| Timid            | rabbit           | 3.0              |
| Pulse            | hand             | 9.0              |
| Mystery          | religion         | 5.2              |
| Savage           | wolf             | 2.4              |
| Spirit           | angel            | 2.4              |
| Teeth            | to eat           | 2.6              |
| Bargain          | profit           | 5.0              |
| Blunder          | mistake          | 3.0              |
| Temper           | nervous          | 2.2              |
| Abrupt           | cascade          | 2.0              |
| Harp             | sing             | 2.0              |
| Switch           | machine          | 2.4              |
| Wide             | sea              | 2.2              |
| Tailor           | stuff            | 3.0              |
| Income           | money            | 1.5              |
| Splendor         | sun              | 1.8              |
| (Salve) Solve    | lip              | 2.5              |
| Moon             | silver           | 2.2              |
| Frost            | white            | 1.8              |
| License          | wine             | 1.8              |
| Average          |                  | 2.9              |

April 12

| Stimulus<br>Word | Reaction<br>Word | Reaction<br>Time |
|------------------|------------------|------------------|
| Round            | table            | 2.0              |
| Country          | green            | 1.8              |
| Silver           | spoon            | 2.3              |
| Rabbit           | white            | 2.0              |
| Chair            | cushion          | 3.0              |
| Glass            | window           | 2.0              |
| Flower           | odor             | 2.3              |
| Sun              | brightness       | 3.2              |
| Bread            | white            | 2.3              |
| Wood             | hard             | 3.0              |
| Well             | water            | 2.4              |
| Danger           | sea              | 2.0              |
| Tired            | bed              | 2.0              |
| Watch            | gold             | 2.4              |
| Marble           | table            | 1.6              |
| Iron             | bar              | 3.8              |
| Bridge           | iron             | 2.8              |
| Blind            | dark             | 2.4              |
| Pencil           | wood             | 3.0              |
| Candy            | sweet            | 3.4              |
| Average          |                  | 2.5              |

April 14

| Stimulus<br>Word | Reaction<br>Word | Reaction<br>Time |
|------------------|------------------|------------------|
| Accept           | a reward         | 2.8              |
| Air              | blue             | 2.6              |
| Able             | sailor           | 2.0              |
| Abuse            | drink            | 2.6              |
| Address          | letter           | 1.8              |
| Blood            | red              | 1.1              |
| Bad              | man              | 1.4              |
| Age              | go               | 1.2              |
| Agree            | wife             | 1.0              |
| Boot             | black            | 1.8              |
| (Tall) Ball      | tree             | 1.6              |
| Balance          | weight           | 1.6              |
| Amuse            | theatre          | 1.4              |
| Bottle           | ink              | 1.4              |
| Band             | brass            | 1.4              |
| Climate          | mild             | .8               |
| Bite             | dog              | 1.5              |
| Box              | wooden           | 1.6              |
| Contents         | book             | 6.4              |
| Boy              | small            | 1.8              |
| Average          |                  | 1.9              |

*April 15*

| Stimulus<br>Word | Reaction<br>Word | Reaction<br>Time |
|------------------|------------------|------------------|
| Catch            | bird             | 1.6              |
| Brain            | human            | 2.6              |
| Broad            | street           | 1.4              |
| Courage          | man              | 2.2              |
| Cease            | speak            | 2.2              |
| Brick            | red              | 1.6              |
| Broken           | glass            | 1.0              |
| Culture          | physical culture | 1.6              |
| Compel           | servant          | 3.4              |
| Cable            | iron wire        | 1.4              |
| Central          | station          | 1.6              |
| Crowd            | people           | 1.2              |
| Confess          | priest           | 1.0              |
| Carbon           | carbon dioxide   | 1.8              |
| Common           | sense            | 1.0              |
| Day              | night            | 2.0              |
| Control          | engine           | 1.0              |
| Chain            | iron             | 1.0              |
| Course           | study            | 2.2              |
| Delegate         | apostolic        | 2.0              |
| Average          |                  | 1.7              |

*April 17*

| Stimulus<br>Word | Reaction<br>Word | Reaction<br>Time |
|------------------|------------------|------------------|
| Crawl            | serpent          | 2.0              |
| Clown            | buffoon          | 2.4              |
| Dizzy            | headache         | 1.6              |
| Distance         | my country       | 2.0              |
| Cure             | physic           | 2.6              |
| Corn             | grass            | 1.8              |
| Easy             | chair            | 1.8              |
| Distress         | sorrow           | 2.0              |
| Decorate         | church           | 1.6              |
| Copper           | metal            | 1.4              |
| Even             | ground           | 2.4              |
| Endurance        | fasting          | 1.4              |
| Decline          | age              | 1.0              |
| Cream            | sweet            | 2.0              |
| Firm             | strong           | 3.4              |
| East             | west             | 1.0              |
| Degrade          | man              | 1.8              |
| Corset           | woman            | 1.0              |
| Flat             | floor            | 1.8              |
| End              | book             | 3.0              |
| Average          |                  | 1.9              |

*April 16*

| Stimulus<br>Word | Reaction<br>Word | Reaction<br>Time |
|------------------|------------------|------------------|
| Defend           | Country          | 1.8              |
| Deck             | ship             | 1.2              |
| Fresh            | air              | .8               |
| Faculty          | arts             | 1.0              |
| Deduct           | sum              | 1.4              |
| Dinner           | good             | 1.4              |
| Flavor           | odor             | 2.2              |
| Displease        | anyone           | 3.2              |
| Dog              | large            | 2.0              |
| Good             | man              | .6               |
| Fault            | his fault        | 3.0              |
| Egg              | white            | 1.4              |
| Green            | tree             | 1.8              |
| Fright           | dog              | 2.2              |
| Drive            | horse            | 1.2              |
| Fairy            | tale             | 1.4              |
| Hard             | stone            | .8               |
| Function         | ceremony         | 3.2              |
| Profess          | religion         | 1.4              |
| Salt             | sea              | 1.4              |
| Average          |                  | 1.7              |

*April 18*

| Stimulus<br>Word | Reaction<br>Word | Reaction<br>Time |
|------------------|------------------|------------------|
| Hit              | hammer           | 3.0              |
| Swallow          | food             | 1.2              |
| Suffer           | pain             | 1.2              |
| Build            | house            | 1.3              |
| Rubber           | teeth            | 1.4              |
| Food             | good             | 1.0              |
| Park             | large            | 1.1              |
| Boat             | swim             | 1.8              |
| Smooth           | floor            | 1.1              |
| Straight         | way              | 1.8              |
| Ugly             | man              | 1.8              |
| Gentle           | woman            | 1.4              |
| Naughty          | man              | 2.0              |
| Power            | England          | 1.6              |
| Strength         | athlete          | 1.9              |
| Charm            | woman            | 3.0              |
| Cost             | money            | 1.0              |
| Kindness         | woman            | 2.2              |
| Break            | glass            | 1.2              |
| Jaw              | mouth            | 1.8              |
| Average          |                  | 1.6              |

| <i>April 19</i> |          |          | <i>April 21</i> |           |          |
|-----------------|----------|----------|-----------------|-----------|----------|
| Stimulus        | Reaction | Reaction | Stimulus        | Reaction  | Reaction |
| Word            | Word     | Time     | Word            | Word      | Time     |
| Produce         | field    | 1.4      | Pinch           | pin       | 1.4      |
| Cry             | baby     | 1.0      | Satisfy         | appetite  | .8       |
| Freeze          | cold     | 1.6      | Nourish         | food      | 1.2      |
| Follow          | soldier  | 5.8      | Drift           | wind      | .8       |
| Smoke           | pipe     | .8       | Abuse           | drink     | 1.2      |
| Rope            | long     | 2.0      | Ditch           | deep      | 1.2      |
| Omlet           | eat      | 1.4      | Tiger           | fierce    | 1.0      |
| Cap             | head     | 1.0      | Music           | sweet     | 1.0      |
| Burglar         | thief    | 1.6      | Fish            | sea       | 1.4      |
| Delicate        | woman    | .8       | Death           | eternal   | (22.4)   |
| Thick           | paper    | 2.8      | Soft            | paste     | 2.4      |
| Expensive       | money    | 1.0      | Ugly            | man       | 1.2      |
| Dark            | night    | 1.0      | Watchful        | policeman | 2.6      |
| Unfair          | unjust   | 2.0      | Indecent        | conduct   | 3.0      |
| Purpose         | scope    | 1.0      | Haste           | hurry     | 1.0      |
| Glory           | eternal  | 1.2      | Comfort         | good      | 2.0      |
| Mischief        | bad      | 2.0      | Adventure       | strange   | 1.2      |
| Occasion        | accident | 1.0      | Practice        | long      | 1.8      |
| Nuisance        | wrong    | 1.6      | Untrue          | falsehood | 1.6      |
| Overcoat        | dress    | 1.0      | Merit           | high      | 2.8      |
| Average         |          | 1.6      | Average         |           | 1.6      |

| <i>April 20</i> |             |          | <i>April 22</i> |          |          |
|-----------------|-------------|----------|-----------------|----------|----------|
| Stimulus        | Reaction    | Reaction | Stimulus        | Reaction | Reaction |
| Word            | Word        | Time     | Word            | Word     | Time     |
| Prefer          | office      | 2.4      | Eat             | bread    | 2.0      |
| Crush           | crowd       | 2.0      | Open            | door     | 1.0      |
| Allow           | pension     | 1.6      | Divide          | reign    | 1.8      |
| Drink           | water       | 1.2      | Fade            | flower   | 1.6      |
| (Solution)      | salt        | 2.2      | Travel          | ship     | 2.0      |
| Salute          |             |          | Umbrella        | rain     | .8       |
| Hip             | thigh       | 1.2      | Gift            | gold     | 3.0      |
| Lightening      | thunder     | 2.0      | Man             | long     | .8       |
| Parlor          | bedroom     | 2.4      | Sailor          | ship     | 1.2      |
| Snake           | serpent     | 1.0      | School          | teacher  | 1.2      |
| Wicked          | man         | 1.2      | Dense           | air      | 2.0      |
| Rich            | millionaire | 1.8      | Short           | man      | 1.4      |
| Clean           | body        | 1.2      | Weary           | travel   | 1.6      |
| Bashful         | woman       | 1.0      | Best            | book     | 5.4      |
| True            | religion    | 5.2      | Excuse          | pardon   | 1.6      |
| Exchange        | money       | 1.0      | Insult          | bad      | 3.8      |
| Style           | literature  | 1.0      | Prudence        | woman    | 1.6      |
| Power           | gun         | 1.0      | Caution         | wise man | 2.2      |
| Result          | good        | 1.4      | Conceit         | ambition | 2.2      |
| Nonsense        | foolish     | 1.6      | Captain         | ship     | 1.4      |
| Seed            | plant       | 1.0      | Average         |          | 1.9      |
| Average         |             | 1.7      |                 |          |          |

*April 23*

| Stimulus Word | Reaction Word | Reaction Time |
|---------------|---------------|---------------|
| Collapse      | sick          | 2.4           |
| Excite        | nervous       | 1.6           |
| Begin         | book          | 1.8           |
| Prosper       | progress      | 2.4           |
| Hat           | head          | 1.2           |
| Sister        | brother       | 1.0           |
| Ham           | meat          | 2.0           |
| Crime         | justice       | 2.8           |
| Tight         | shoe          | 2.0           |
| Solid         | stone         | 1.8           |
| Cold          | winter        | 1.6           |
| Clear         | sky           | 1.4           |
| Hope          | fortune       | 3.6           |
| Dismay        | fear          | 1.6           |
| Offense       | insult        | 1.4           |
| Blunder       | mistake       | 1.0           |
| Future        | time          | 4.0           |
| Insist        | persist       | 2.4           |
| Trap          | wolf          | 2.0           |
| Oblong        | square        | 1.4           |
| Average       |               | 2.0           |

*April 25*

| Stimulus Word | Reaction Word | Reaction Time |
|---------------|---------------|---------------|
| Join          | chain         | 1.8           |
| Clasp         | hand          | 1.0           |
| Advance       | pretention    | 2.0           |
| Argue         | discussion    | 2.0           |
| Mountain      | large         | 1.0           |
| House         | beautiful     | 1.4           |
| Neck          | strong        | 1.0           |
| Lamb          | quiet         | 1.2           |
| Hero          | brave         | 1.2           |
| Jealous       | woman         | 1.4           |
| White         | snow          | 2.0           |
| Serious       | man           | 1.0           |
| Vacant        | space         | 1.0           |
| Fertile       | land          | 1.0           |
| Reason        | mind          | 1.6           |
| Protection    | government    | 1.8           |
| Solemnity     | festivity     | 1.0           |
| Impudence     | woman         | 3.8           |
| Convenience   | etiquette     | 3.0           |
| Scratch       | nail          | 1.6           |
| Average       |               | 1.6           |

*April 24*

| Stimulus Word | Reaction Word | Reaction Time |
|---------------|---------------|---------------|
| Restore       | furniture     | 1.4           |
| Impress       | printing      | 1.8           |
| Flirt         | woman         | 1.0           |
| Ask           | question      | 1.2           |
| Receive       | letter        | .8            |
| Baker         | bread         | 1.0           |
| Athlete       | strength      | 1.0           |
| Cradle        | baby          | 1.0           |
| Bundle        | hay           | 1.0           |
| Elephant      | trunk         | 1.0           |
| Cheap         | money         | 3.0           |
| Black         | dog           | .8            |
| Tender        | meat          | 1.4           |
| Prompt        | answer        | 1.4           |
| Ignorant      | man           | 1.0           |
| Confidence    | familiarity   | 2.0           |
| Jealousy      | woman         | .8            |
| Honesty       | good          | 4.2           |
| Unbelief      | atheist       | 2.4           |
| Heroism       | warrior       | 2.0           |
| Average       |               | 1.5           |

*April 26*

| Stimulus Word | Reaction Word | Reaction Time |
|---------------|---------------|---------------|
| Forget        | memory        | 1.2           |
| Dislike       | people        | 1.0           |
| Prepare       | lesson        | 1.0           |
| Admire        | virtue        | 1.8           |
| Protect       | children      | 1.6           |
| Starch        | white         | 1.2           |
| Mutton        | meat          | 1.4           |
| Ostrich       | feather       | 1.0           |
| Roof          | house         | 2.0           |
| Little        | boy           | 1.0           |
| Funny         | buffoon       | 2.2           |
| Gay           | sun           | 1.2           |
| Dead          | black         | 1.2           |
| Slow          | worm          | 1.6           |
| Solemnity     | feast         | 1.6           |
| Annoyance     | fly           | 1.0           |
| Constancy     | virtue        | 3.2           |
| Attention     | mind          | 1.4           |
| Uncertainty   | pendulum      | (12.6)        |
| Average       |               | 1.4           |

*April 27*

| Stimulus<br>Word | Reaction<br>Word | Reaction<br>Time |
|------------------|------------------|------------------|
| Accuse           | judge            | 1.8              |
| Appear           | star             | 2.0              |
| Polish           | wood             | 1.2              |
| Repeat           | lesson           | 1.0              |
| Condemn          | delinquent       | 2.4              |
| Car              | motor            | 1.8              |
| Knee             | leg              | 1.8              |
| Cloud            | white            | 1.2              |
| Fun              | joy              | 1.8              |
| Violent          | wind             | 1.2              |
| Sour             | acid             | 1.0              |
| Dim              | sound            | 1.0              |
| Condition        | good             | 1.0              |
| Deceit           | deceive          | 3.0              |
| Fraud            | wrong            | 3.0              |
| Brutality        | animal           | 2.0              |
| Cup              | wine             | 1.2              |
| Equality         | fraternity       | 3.0              |
| Greasy           | pole             | 1.2              |
| Violet           | odor             | 1.0              |

Average

1.7

*April 29*

| Stimulus<br>Word | Reaction<br>Word | Reaction<br>Time |
|------------------|------------------|------------------|
| Announce         | news             | 1.2              |
| Stain            | ink              | 1.0              |
| Finish           | lesson           | 1.4              |
| Drag             | horse            | 2.0              |
| Plead            | case             | 2.0              |
| Cork             | bottle           | 2.0              |
| Toy              | child            | 1.2              |
| Key              | door             | 1.2              |
| Ox               | horns            | 2.2              |
| River            | water            | 1.6              |
| Rusty            | iron             | 1.6              |
| Ungracious       | bear             | 2.0              |
| Irksome          | science          | 2.4              |
| Equal            | balance          | 4.0              |
| Late             | hour             | 1.2              |
| Accusation       | importation      | 2.0              |
| Corruption       | money            | 2.0              |
| Poverty          | distress         | 3.2              |
| Imposition       | tax              | 1.0              |
| Adoration        | Saint            | 1.4              |

Average

1.8

*April 28*

| Stimulus<br>Word            | Reaction<br>Word | Reaction<br>Time |
|-----------------------------|------------------|------------------|
| Persuade                    | argument         | 2.4              |
| Dig                         | ditch            | 1.0              |
| Get                         | money            | 1.0              |
| Sting                       | bee              | 2.2              |
| Preach                      | priest           | 1.0              |
| Spice                       | pepper           | .8               |
| Star                        | Venus            | 1.4              |
| Ice                         | cold             | 1.0              |
| Picture                     | beautiful        | 1.8              |
| Lip                         | red              | 1.4              |
| Easy                        | chair            | 1.0              |
| Unclean                     | dirty            | 1.4              |
| Red                         | rose             | 1.0              |
| Rotten                      | mud              | 2.0              |
| Hard                        | flint            | 1.0              |
| Proposition                 | geometry         | 1.6              |
| Improvement                 | progress         | 1.0              |
| Infamy                      | calumny          | 2.2              |
| Competition<br>(competence) | commerce         | 2.4              |
| Attraction                  | actress          | 2.0              |

Average

1.5

*April 30*

| Stimulus<br>Word | Reaction<br>Word | Reaction<br>Time |
|------------------|------------------|------------------|
| Adore            | Saint            | 2.2              |
| Perish           | ship             | 2.2              |
| Propose          | marriage         | 1.4              |
| Uphold           | politics         | 2.8              |
| Descend          | stairs           | 1.2              |
| Slave            | misery           | 2.8              |
| Violin           | music            | 2.0              |
| (Path) Pot       | country          | 2.4              |
| Chapel           | church           | 1.4              |
| Trumpet          | sound            | 1.2              |
| Supreme          | being            | 1.2              |
| Elegant          | woman            | 1.6              |
| Impudent         | woman            | 2.0              |
| Blame            | offense          | 2.4              |
| Gain             | money            | 1.0              |
| Idea             | noble            | 1.0              |
| Worship          | God              | 1.0              |
| Elevation        | Spirit           | 1.4              |
| Noisy            | metronome        | 2.0              |
| level            | ground           | 1.0              |

Average

1.7

| <i>May 1</i> |            |          | <i>May 3</i> |            |          |
|--------------|------------|----------|--------------|------------|----------|
| Stimulus     | Reaction   | Reaction | Stimulus     | Reaction   | Reaction |
| Word         | Word       | Time     | Word         | Word       | Time     |
| Escape       | prison     | 2.0      | Guide        | a traveler | 6.4      |
| Admit        | argument   | 2.0      | Care         | a boy      | 2.3      |
| Joke         | play       | 3.0      | Denounce     | principles | 3.8      |
| Improve      | mind       | 1.6      | Drop         | stone      | 1.4      |
| Defy         | enemy      | 1.2      | Suspect      | fault      | 2.2      |
| Lamp         | fire       | 2.0      | Saddle       | horse      | 1.6      |
| Cabbage      | green      | 1.0      | Sleep        | bed        | 2.2      |
| Paste        | soft       | 1.2      | Fog          | fruit      | 1.0      |
| Poem         | beautiful  | 1.0      | Skin         | animal     | 1.4      |
| Spear        | piercing   | 2.6      | Earth        | ground     | 3.2      |
| Harsh        | sound      | 1.2      | Rough        | weather    | 1.2      |
| Unripe       | fruit      | 1.0      | High         | mountain   | 1.2      |
| Unwell       | sick       | 1.0      | Idle         | servant    | 1.4      |
| Vile         | fellow     | 1.0      | Humble       | man        | 2.0      |
| Admission    | employment | 3.0      | Active       | boy        | 2.4      |
| Thankfulness | gratitude  | 2.0      | Health       | good       | 1.4      |
| Dishonor     | bad        | 3.6      | Aim          | noble      | 1.8      |
| Intimacy     | friendship | 1.0      | Fame         | vain       | 2.8      |
| Revenge      | fault      | 3.4      | Shame        | wrong      | 2.0      |
| Least        | thing      | 2.6      | Ability      | great      | 1.2      |
|              | Average    | 1.9      |              | Average    | 2.1      |

| <i>May 2</i> |           |          | <i>May 4</i> |              |          |
|--------------|-----------|----------|--------------|--------------|----------|
| Stimulus     | Reaction  | Reaction | Stimulus     | Reaction     | Reaction |
| Word         | Word      | Time     | Word         | Word         | Time     |
| Deny         | favor     | 2.0      | Fast         | long         | 1.4      |
| Burn         | fire      | 1.6      | Dream        | sleep        | 2.6      |
| Paint        | wall      | 1.8      | Taste        | food         | 1.2      |
| Betray       | faith     | 1.2      | Cook         | food         | 1.4      |
| Dress        | clothes   | 1.4      | Mark         | ink          | 1.0      |
| Mouse        | black     | 2.0      | Sparrow      | bird         | 1.0      |
| Barn         | corn      | 3.0      | Foot         | large        | 1.6      |
| Song         | beautiful | 1.4      | Spider       | insect       | 3.2      |
| Spider       | feet      | 2.6      | Forest       | trees        | 1.0      |
| Scarlet      | fever     | 1.6      | Stone        | heavy        | 1.0      |
| Beautiful    | woman     | 1.4      | Purple       | color        | 1.0      |
| Yellow       | fever     | 1.8      | Infamous     | calumny      | 1.2      |
| Modest       | girl      | 2.0      | Refined      | art          | 1.2      |
| Wealthy      | man       | 2.0      | Ungracious   | bear         | 1.8      |
| Justice      | right     | 1.4      | Center       | circle       | 1.6      |
| Trouble      | bad       | 2.0      | Awkward      | gait         | 1.8      |
| Quantity     | large     | 1.6      | Supremacy    | authority    | 2.0      |
| Reproach     | fault     | 1.2      | Constancy    | perseverance | 1.6      |
| Energy       | force     | 2.0      | Time         | quick        | 1.2      |
| Crack        | nuts      | 1.0      | Gin          | bad          | 1.0      |
|              | Average   | 1.8      |              | Average      | 1.5      |

| <i>May 5</i> |            |          | <i>May 7</i> |            |          |
|--------------|------------|----------|--------------|------------|----------|
| Stimulus     | Reaction   | Reaction | Stimulus     | Reaction   | Reaction |
| Word         | Word       | Time     | Word         | Word       | Time     |
| Invite       | guest      | 1.6      | Wash         | clothes    | 1.0      |
| Pin          | clothes    | 1.4      | Elevate      | thought    | 1.4      |
| Tremble      |            |          | Deceive      | wrong      | 2.6      |
| (Crumble)    | bread      | 1.4      | Ramble       | about      | 1.6      |
| Attack       | enemy      | 1.2      | Decay        | reign      | 1.8      |
| Wood         | hard       | 2.0      | Bible        | holy       | 1.4      |
| Dirt         | nasty      | 3.2      | Pencil       | lead       | 1.0      |
| Shoe         | tight      | 1.2      | Crown        | king       | 1.0      |
| Camp         | large      | 1.8      | Goat         | milk       | 1.2      |
| Cannon       | big        | 2.6      | Candy        | sweet      | .8       |
| Ashamed      | fault      | 1.4      | Restless     | not quiet  | 2.0      |
| Unsafe       | war        | 1.6      | Simple       | countryman | 1.6      |
| Raw          | fruit      | 2.0      | Reckless     | man        | 1.2      |
| Smooth       | ground     | 1.2      | Eternal      | life       | 1.2      |
| Fortune      | money      | 1.4      | Prosperity   | fortune    | 1.0      |
| Disdain      | angry      | 2.0      | Jealousy     | woman      | 1.2      |
| Refinement   | art        | 1.8      | Concealment  | to hide    | 2.4      |
| Activity     | work       | 1.2      | Advancement  | progress   | .8       |
| Accident     | misfortune | 1.6      | Rancid       | butter     | 1.4      |
| Scoff        | offender   | 2.4      | Honesty      | good       | 1.0      |
| Noisy        | clock      | 2.0      |              |            |          |
|              | Average    | 1.8      |              | Average    | 1.4      |

| <i>May 6</i> |           |          | <i>May 8</i> |             |          |
|--------------|-----------|----------|--------------|-------------|----------|
| Stimulus     | Reaction  | Reaction | Stimulus     | Reaction    | Reaction |
| Word         | Word      | Time     | Word         | Word        | Time     |
| Dishonor     | sin       | 2.4      | Deserve      | merit       | 1.2      |
| Remove       | furniture | 1.6      | Wish         | fortune     | 2.4      |
| Injure       | sword     | 2.4      | Boast        | glory       | 3.2      |
| Plunge       | water     | 1.0      | Establish    | manufactory | 1.1      |
| Murder       | thief     | 1.4      | Barber       | razor       | 1.6      |
| Garden       | flower    | 1.0      | Pebble       | stone       | 1.4      |
| Nut          | crack     | 2.0      | Heart        | beat        | 1.2      |
| Stem         | heraldry  | 2.0      | Machine      | work        | 1.4      |
| Crab         | animal    | 2.0      | Statue       | marble      | 1.2      |
| Pickle       | burning   | 2.0      | Certain      | thing       | 2.0      |
| Noble        | gentleman | 1.6      | Natural      | régime      | 1.8      |
| Nice         | fellow    | 1.2      | Correct      | grammar     | 2.0      |
| Secure       | keys      | 1.0      | Dusty        | street      | .8       |
| Blue         | sky       | 2.0      | Enormous     | building    | 1.6      |
| Swift        | sparrow   | 1.4      | Commandment  | God         | 1.0      |
| Disgrace     | fault     | 2.0      | Excitement   | nervous     | .8       |
| Security     | policeman | 2.2      | Restoration  | food        | 1.6      |
| Unhappiness  | marriage  | 2.8      | Density      | mercury     | 1.8      |
| Rhyme        | poetry    | 1.0      | Infirmity    | sickness    | 1.8      |
| Disaster     | Titanic   | 1.2      | Return       | voyage      | 1.6      |
|              | Average   | 1.7      |              | Average     | 1.6      |

| <i>May 9</i>  |               |               | <i>May 11</i> |               |               |
|---------------|---------------|---------------|---------------|---------------|---------------|
| Stimulus Word | Reaction Word | Reaction Time | Stimulus Word | Reaction Word | Reaction Time |
| Paper         | write         | 1.2           | Plunge        | water         | 1.0           |
| Bright        | sun           | .6            | Guess         | enigma        | 2.4           |
| Yellow        | fever         | 1.4           | Rescue        | wrecked       | 1.8           |
| Table         | mahogany      | 3.2           | Believe       | God           | 1.4           |
| Spoon         | food          | 1.4           | Carve         | wood          | 1.0           |
| Apple         | fruit         | .8            | Door          | house         | 1.8           |
| Sleep         | night         | 2.4           | Barley        | corn          | 1.0           |
| Cut           | animal        | 1.8           | Eagle         | bird          | 1.0           |
| Face          | beautiful     | 1.2           | Chin          | face          | 1.6           |
| Carpet        | ground        | 1.4           | Pulse         | beating       | 1.0           |
| Animal        | fierce        | 1.6           | Alive         | man           | 1.2           |
| Rain          | weather       | 1.8           | Exquisite     | sweet         | 1.6           |
| Teach         | lesson        | 1.8           | Empty         | barrel        | 1.2           |
| Doctor        | medicine      | 1.0           | Bitter        | quassia       | 1.8           |
| Book          | interesting   | 1.4           | Lazy          | fellow        | .8            |
| Store         | goods         | 3.0           | Modesty       | virtue        | 1.0           |
| Horse         | animal        | 1.6           | Immensity     | God           | 1.6           |
| Island        | Malta         | 1.2           | Preservation  | alcohol       | 1.8           |
| Journey       | long          | 1.0           | Prudence      | virtue        | 1.2           |
| Freedom       | liberty       | .8            | Indiscretion  | vice          | 1.2           |
| Average       |               | 1.5           | Average       |               | 1.4           |

| <i>May 10</i> |               |               | <i>May 12</i> |               |               |
|---------------|---------------|---------------|---------------|---------------|---------------|
| Stimulus Word | Reaction Word | Reaction Time | Stimulus Word | Reaction Word | Reaction Time |
| Roast         | meat          | 1.0           | Find          | treasure      | 2.0           |
| View          | panorama      | 1.8           | Praise        | merit         | 2.0           |
| Whistle       | a whistle     | 1.4           | Pump          | water         | 1.0           |
| Alarm         | people        | 2.6           | Try           | lesson        | 1.8           |
| Indulge       | drinker       | 1.4           | Guard         | tower         | 1.8           |
| Frost         | white         | 1.4           | Iron          | metal         | 1.8           |
| Cask          | wine          | 1.0           | Stomach       | empty         | 1.8           |
| Curtain       | silk          | 1.4           | Salmon        | fish          | 1.0           |
| Nurse         | baby          | 1.2           | Bath          | water         | 1.2           |
| Ivy           | wall          | 1.4           | Splinter      | wood          | 1.2           |
| Thankful      | grateful      | 1.0           | Unfit         | unable        | 2.0           |
| Steep         | stairs        | 1.2           | Ardent        | fire          | 1.2           |
| Unwholesome   | air           | 1.0           | North         | south         | 2.2           |
| Gentle        | woman         | 1.4           | Handsome      | lady          | 1.2           |
| Faithful      | servant       | 1.0           | Price         | high          | 2.2           |
| Conflict      | nations       | 1.2           | Appetite      | good          | 1.2           |
| Anger         | bad           | 2.2           | Fable         | Aesop         | 2.0           |
| Idleness      | vice          | 2.4           | Definition    | grammar       | 1.8           |
| Betrayal      | traitor       | 1.8           | Queer         | sound         | 2.2           |
| Denouncement  | fault         | 2.0           | Ingenuity     | simplicity    | 1.4           |
| Average       |               | 1.5           | Average       |               | 1.7           |

| <i>May 13</i> |             |          | <i>May 15</i> |                |          |
|---------------|-------------|----------|---------------|----------------|----------|
| Stimulus      | Reaction    | Reaction | Stimulus      | Reaction       | Reaction |
| Word          | Word        | Time     | Word          | Word           | Time     |
| Distrust      | enemy       | 1.8      | Sin           | bad            | 1.4      |
| Run           | along way   | 2.0      | Applaud       | merit          | .8       |
| Agree         | friend      | 1.2      | Astonish      | marvel         | 1.6      |
| Needle        | thread      | 1.2      | Rejoice       | good news      | 2.0      |
| Chocolate     | sweet       | 1.0      | Use           | tools          | 1.2      |
| Twig          | tree        | 1.2      | Spool         | loom           | 1.4      |
| Napkin        | white       | 1.2      | Sheep         | fur            | 1.6      |
| Hill          | steep       | 1.4      | Emerald       | precious stone | 1.8      |
| Finger        | hand        | 1.0      | Wagon         | coal           | 1.6      |
| Pretty        | girl        | 1.2      | Cottage       | college        | 1.6      |
| Contented     | happy       | 1.0      | Naughty       | boy            | 1.2      |
| Absent        | minded      | 1.8      | Exacting      | demand         | 2.6      |
| Magical       | lantern     | 1.4      | Thirsty       | man            | 1.2      |
| Profane       | words       | 1.2      | Playful       | boy            | 1.2      |
| Introduction  | to a friend | 1.4      | Impulsive     | dashing        | 1.8      |
| Amusement     | theatre     | 1.2      | Faithfulness  | dog            | 1.0      |
| Remorse       | sin         | .8       | Provocation   | insult         | 1.4      |
| Calmness      | quietness   | 1.2      | Contentment   | happiness      | 1.0      |
| Nod           | head        | 1.0      | Religion      | faith          | 1.0      |
| Calculate     | Numbers     | 1.0      | Profanity     | bad word       | 1.0      |
|               | Average     | 1.3      |               | Average        | 1.4      |

| <i>May 14</i> |              |          | <i>June 2, 1913</i> |           |          |
|---------------|--------------|----------|---------------------|-----------|----------|
| Stimulus      | Reaction     | Reaction | Stimulus            | Reaction  | Reaction |
| Word          | Word         | Time     | Word                | Word      | Time     |
| Shock         | electricity  | 1.4      | Adore               | God       | 1.0      |
| Sweat         | heat         | 1.8      | Perish              | ship      | 1.0      |
| Melt          | snow         | 1.4      | Propose             | marriage  | 1.1      |
| Stun          | hit          | 1.4      | Uphold              | opinion   | 1.8      |
| Hunt          | deer         | 2.0      | Descend             | mountain  | 1.2      |
| Maiden        | woman        | 1.8      | Slave               | poor      | 2.2      |
| Bag           | sand         | 2.0      | Violin              | song      | 1.6      |
| Belt          | leather      | 1.2      | Brook               | river     | 1.0      |
| Cake          | sweet        | 1.2      | Chapel              | church    | 1.0      |
| Unhappy       | miserable    | 1.6      | Trumpet             | sound     | 1.0      |
| Pure          | blood        | 1.8      | Supreme             | Being     | 1.2      |
| Disorderly    | irregularity | 1.6      | Elegant             | lady      | 1.2      |
| Unemployed    | poor         | 2.0      | Impudent            | boy       | 2.8      |
| Wretched      | miserable    | 2.0      | Blame               | fault     | 2.1      |
| Indulgence    | vice         | 1.6      | Gain                | money     | .8       |
| Agreement     | friendship   | 1.2      | Idea                | beautiful | 1.4      |
| Advantage     | benefit      | 1.2      | Worship             | God       | 1.6      |
| Injury        | blow         | 1.2      | Comfort             | pleasure  | 3.0      |
| Outrage       | war          | 1.6      | Noisy               | room      | 1.0      |
| Rubber        | teeth        | 1.6      | Level               | ground    | 1.0      |
|               | Average      | 1.6      |                     | Average   | 1.4      |

| <i>June 3</i> |            |          | <i>June 5</i> |          |          |
|---------------|------------|----------|---------------|----------|----------|
| Stimulus      | Reaction   | Reaction | Stimulus      | Reaction | Reaction |
| Word          | Word       | Time     | Word          | Word     | Time     |
| Cover         | hat        | 1.3      | Oppose        | enemy    | 1.2      |
| Hasten        | pace       | 1.0      | Enter         | house    | 1.2      |
| Curse         | son        | 3.6      | Drive         | horse    | 1.0      |
| Hurt          | wound      | 1.4      | Lecture       | public   | 2.2      |
| Blush         | young lady | 2.2      | Flag          | wave     | 1.0      |
| Island        | Malta      | .8       | Ivory         | white    | 1.0      |
| Copper        | mental     | 1.0      | Bed           | sleep    | 1.2      |
| Water         | flowing    | 1.0      | Fountain      | water    | 1.0      |
| Lettuce       | vegetable  | 1.4      | Pie           | lemon    | 1.6      |
| Brandy        | alcohol    | 1.0      | Awake         | morning  | 1.4      |
| Unseen        | God        | 1.0      | Dull          | night    | 1.4      |
| Merry         | happy      | 1.6      | Many          | friends  | 1.8      |
| Sacred        | church     | 1.4      | Green         | leaves   | 1.2      |
| Excellent     | exam       | 1.6      | Divine        | God      | 1.0      |
| Adorable      | Saint      | 1.4      | Terror        | enemy    | 1.2      |
| Life          | Eternal    | 1.2      | Spite         | hatred   | 1.4      |
| Opposition    | enemy      | 1.2      | Advice        | council  | 2.0      |
| Intellect     | mind       | 1.2      | Contempt      | enemy    | 1.8      |
| Sorrow        | grief      | 1.4      | Dispute       | question | 1.2      |
| Education     | school     | 1.2      | Telephone     | friend   | 2.6      |
|               | Average    | 1.4      |               | Average  | 1.4      |

| <i>June 4</i> |          |          | <i>June 6</i> |          |          |
|---------------|----------|----------|---------------|----------|----------|
| Stimulus      | Reaction | Reaction | Stimulus      | Reaction | Reaction |
| Word          | Word     | Time     | Word          | Word     | Time     |
| Caress        | baby     | 1.4      | Scold         | child    | 1.0      |
| Reduce        | salary   | 1.0      | Walk          | street   | 1.0      |
| Reward        | behavior | 1.8      | Punish        | criminal | 2.2      |
| Talk          | English  | 1.0      | Smell         | odor     | 1.2      |
| Touch         | table    | 1.0      | Send          | letter   | 1.4      |
| Street        | long     | 1.0      | Mill          | flour    | 1.0      |
| Cane          | reed     | 1.2      | Elbow         | hand     | 1.2      |
| Soap          | soft     | 1.4      | Milk          | white    | 1.0      |
| Cheese        | English  | 2.0      | Scissors      | cut      | 1.2      |
| Drum          | sound    | 1.0      | Moon          | night    | 1.2      |
| Happy         | healthy  | 2.2      | Quiet         | night    | 1.4      |
| Small         | boy      | 1.0      | Infinite      | God      | 1.0      |
| Difficult     | lesson   | 1.2      | Brave         | soldier  | 1.4      |
| Painful       | wound    | 1.2      | Ornamental    | church   | 1.0      |
| Grief         | sorrow   | 1.0      | Dreadful      | fight    | 1.4      |
| Thought       | good     | 1.4      | Chance        | good     | 1.4      |
| Credit        | great    | 1.6      | Quarrel       | men      | 2.0      |
| Fear          | death    | 1.4      | Conscience    | good     | 1.2      |
| Mercy         | God      | 1.2      | Scandal       | bad      | 1.8      |
| Sinful        | man      | 1.0      | Evil          | bad      | 1.6      |
|               | Average  | 1.3      |               | Average  | 1.3      |

*June 7*

| Stimulus<br>Word | Reaction<br>Word | Reaction<br>Time |
|------------------|------------------|------------------|
| Irritate         | nerves           | 1.0              |
| Tame             | animal           | 1.0              |
| Feed             | animal           | 1.2              |
| Imagine          | vision           | 1.0              |
| Suffer           | pain             | 1.0              |
| Dinner           | good             | 1.2              |
| Raft             | sea              | 1.2              |
| Chart            | fever            | 1.8              |
| Glove            | hand             | 1.0              |
| Bird             | sing             | 1.2              |
| Afraid           | lion             | 1.0              |
| Blue             | sky              | .8               |
| Anxious          | desirous         | 1.2              |
| Long             | street           | 1.0              |
| Audacious        | hero             | 1.2              |
| Expression       | vocal            | 1.2              |
| Mistake          | great            | 1.2              |
| Devotion         | church           | 1.2              |
| Errand           | boy              | 1.0              |
| Expense          | great            | 1.4              |
| Average          |                  | 1.14             |

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STUDIES FROM THE PSYCHOLOGICAL LABORATORY  
OF HARVARD UNIVERSITY

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